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FOR THE JOURNAL OF THE FRANKLIN INSTITUTE.

Cost of Transportation on Railroads. *By* C. ELLET, JR., C. E.

[CONTINUED FROM PAGE 304.]

On the Value of Time.

In estimating the cost of transportation on railroads I have taken no account, in the preceding numbers, of an item which is generally considered of great consequence in determining the result; viz. *the value of time.* Speed is the peculiar advantage of railroads, and one which is certainly sometimes deserving of much consideration in the administration of the work. I propose to estimate its real value, as nearly as it can be done, in the transportation of passengers and merchandize.

First, then, what are we to regard as the measure of the value of time on any article of merchandize? Is it not the interest on the capital invested in the commodity, at the rate at which the proprietor estimates his profits for the time, added to the rate at which his goods depreciate in value in consequence of detention on the route?

If this be true—and I cannot well perceive what other value than this the *time* lost in their conveyance can possess—let us endeavour to ascertain to what it will amount under different circumstances; and for this purpose we will represent by

r the rate of interest, and depreciation of the value of the goods, per cent. per annum;

P the value in dollars of one ton of the commodity; and

V any velocity of transportation in miles per hour.

There are 8760 hours in a year; and if we represent this number by m, the interest and depreciation of the value of a ton of goods, in the space of one hour, will be expressed by

$$\frac{P\,r}{100\,m};$$

and during the time the goods are carried one mile at the velocity V, it will amount to the sum

$$\frac{P\,r}{100\,m\,V}.$$

This interest and depreciation, for any other greater velocity V'. will be for the time consumed in traversing one mile

$$\frac{P\,r}{100\,m\,V'};$$

and, consequently, the difference between the values of the two velocities V and V' (supposing that the time and speed be well employed, and that the engine drivers do not waste at the stations and depots what he gains on the route,) for each ton and for one mile, will be

$$\frac{P\,r}{100\,m}\left(\frac{V'-V}{V'\,V}\right). \qquad (K)$$

This expression represents the amount which the goods would depreciate while passing over one mile, at the velocity V, over and above their interest and depreciation while traversing the same distance at the velocity V'; or the additional sum which the owner of the goods would be willing to pay to have them carried at the speed V' instead of the slower rate V.

Now let us apply this equation to the transportation of coal, and assume for the velocity V' that which would be likely to have place on a railroad, or ten miles per hour; and for that of V the ordinary speed of a canal boat, or two and a half miles per hour; for the value of the commodity, *three dollars* per ton, and for the value of the capital employed in the trade, 20 per cent. per annum.

How much per ton per mile would the value of a speed of ten miles per hour exceed that of two and a half miles? By the equation we have here

$$\frac{3\times 20}{8760\times 100}\left(\frac{10-2.5}{10\times 2.5}\right)=\frac{1}{48666}\text{ of a dollar,}$$

or a frcation more than the fiftieth part of one mill per ton per mile.

It would appear, then, if this process be correct, that there is but little encouragement to tear the road, and cars, and engines to pieces—augment the risk of accident, and increase the actual cost of transportation 100 per cent.—for the purpose of delivering coal a few hours sooner than it might be effected on a canal at a speed of two and a half miles per hour. If the value of the coal be not more than three dollars per ton at the mine, and the value of the capital engaged in the trade not more than 20 per cent. per annum, the difference to the proprietor could not amount to more than the *fifth part of one cent per ton for the whole time consumed in traversing a space of* 100 *miles.*

Again, let us suppose that the article is flour, of which the value is six dollars per barrel; and let us, at the same time, assume that the depreciation would be 100 per cent. per annum; which is equivalent to the supposition that it would be entirely destroyed if it were detained one year on the passage, and that the depreciation is uniform during the whole period. We will also suppose that the speed on the railroad is infinitely great, or that a mile might be passed by a locomotive engine in a space of time so short as to be wholly inappreciable; while the speed with which the same article would be transported on a canal is, as usual, two and a half miles per hour.

What is the value of the time lost on the canal in this case? Here we have $r = 100$, $P = 6$, $V' =$ infinite, and $V = 2\frac{1}{2}$; which quantities being substituted in the equation yield

$$\frac{100 \times 6}{8760 \times 100} \cdot \frac{1}{2\frac{1}{2}} = \frac{1}{3650} \text{ of a dollar,}$$

or about the *fourth part of one mill per mile per barrel.*

This will be recognized as rather an extreme case; but still it does not justify a high speed,—for three mills per ton per mile is generally not very perceptible among the quantities which enter into the aggregate expenses of a railroad line.

Let us next suppose the commodity to be groceries—such, for instance, as sugar and coffee—of which the value may be assumed at two hundred dollars per ton; and that the interest and depreciation are equal to 20 per cent. per annum. In this case we will find for the difference between the value of a speed of ten miles per hour, and one of two and a half miles per hour—between the speed of a locomotive and that of a canal boat,

$$\frac{200 \times 20}{8760 \times 100}\left(\frac{10 - 2\frac{1}{2}}{10 \times 2\frac{1}{2}}\right) = \frac{1}{730} \text{ of a dollar,}$$

or about *one and a third mills per ton per mile.* The difference be-

tween the value of a speed of five and one of ten miles per hour, would not in this case have exceeded a half mill per ton per mile.

A high speed, then, is not justifiable in the transportation of groceries for the purpose of saving time in the delivery of the freight. If it be adopted at all it must be because the condition of the road, or some other part of the business which it accommodates, renders it imperative, or because the injury which the work sustains in consequence of the greater velocity is not properly appreciated by the parties in control of the line.

We will next take the case of dry goods, of which the average value may, perhaps, be assumed at 2,000 dollars per ton; the interest and depreciation will again be put at 20 per cent., and the respective velocities at two and a half and fifteen miles per hour.

By the formula we have, in this case,

$$\frac{2000 \times 20}{8760 \times 100}\left(\frac{15 - 2\frac{1}{2}}{15 \times 2\frac{1}{2}}\right) = \frac{1}{66} \text{ of a dollar,}$$

or one cent and a half per ton per mile.

This sum is nearly equal to the actual cost of transportation on a road in good condition; and it is therefore apparent that in the conveyance of trains composed exclusively of the most valuable goods, a greater velocity than two and a half miles per hour is always proper; but when it is recollected that there is never more than a very small proportion of the merchandize passing over a line, which possesses anything like the value here assumed—2,000 dollars per ton—the adoption of a higher velocity must still be regarded as of very doubtful utility. Even in the case before us—where the value of the goods is assumed at 2,000 dollars per ton—the difference between the value of a speed of fifteen miles per hour and one of six miles per hour, would not amount to a half cent per ton per mile—a sum which would by no means justify a high speed even if the train were loaded entirely with such goods.

If we apply the same method of computation to the conveyance of passengers, and estimate the average value of the time of all the individuals in the trains, at twelve cents per hour, we shall have for the difference between the value of a speed of fifteen miles per hour and the usual speed of freight boats on canals, or two and a half miles per hour,

$$12\left(\frac{15 - 2\frac{1}{2}}{15 \times 2\frac{1}{2}}\right) = 4 \textit{ cents per passenger per mile.}$$

If the average time of all the individuals traveling be worth twelve cents per hour, the charges on a road where a speed of fifteen miles

per hour is adopted, *may be four cents per mile higher than could be demanded on one where a velocity of only two and a half miles per hour is maintained.* Of course there is a great difference between the values put on their time by different individuals; and of course too, there must be much uncertainty in fixing upon a general average. But twelve cents per hour (including the expenses incident to the trip) is by no means a high estimate for the time of all the individuals traveling in the public conveyances; but yet, low as it is, it shows for the value of the time of one person—exclusive of what mere impatience would prompt him to pay—a sum nearly two thousand times greater than that of a ton of coal, thirty times greater than that of a hogshead of sugar, and nearly three times that of a ton of ordinary dry goods, transported at the same rate.

We may perceive, then, why the superiority of railroads is so much greater in the transportation of passengers than of heavy freight; and how it may happen that a velocity which is in the highest degree economical when adopted for the convenience of travelers, may be ruinous when applied to the transportation of minerals and produce. Indeed it is difficult to over-estimate the injury which is inflicted on the interests of stockholders, from the continuance of this evil in the management of railroads, although it has been materially abated within the last four years. The value of the additional time which is consumed at the slower rate is absolutely unworthy of consideration in the conveyance of merchandize; and the only question which ought to occupy the attention of the directory is the reduction of the actual expenses of the line, and the selection of that velocity which corresponds with the greatest possible economy. The great and constant effort should be to reduce the cost of transportation to the lowest limit. It is not railroads nor canals that increase the trade of a country or add wealth to the districts which they traverse. It is the reduction of the charges for conveyance which these improvements permit, from which these great advantages are derived. And high speed on such commodities offers no compensation for the high charges which it exacts.

These considerations are applicable only to the value of time on the goods transported. But the loss of interest, and depreciation of the value of the freight, are not the only losses involved in the adoption of an insufficient speed. The value of the time of the *train, and of the train hands,* is also to be considered, and enters into the complete expression of the actual cost of transportation. If the engines and cars, and the men who conduct them, do less duty than they might accomplish by the adoption of a higher velocity, the value of the time of the increase of stock and force which will be required to effect the

same duty at the slower rate, must obviously be charged against that velocity.

It is true that there are cases in which the speed to be adopted is governed by the necessity of accommodating a certain amount of trade, or making room for a large passenger conveyance, which could not be adequately provided for on a single track, without maintaining a speed determined by the circumstances. Of course the company must submit to this necessity; they must adopt a high velocity where these or other imperative conditions exact it. But the question now is, what is the value of velocity or time, where they have the power to exercise their own discretion in the selection of the speed?

In all such cases the slower the motion of the train the less will be the expenses of the company, unless it be reduced so low that the interest on the cars and engines which convey the freight, and the loss of the time of the engine and train hands, more than compensates for the reduced charges for repairs of the road and machinery.

We will designate by F the value of the locomotive engine in dollars; by f the value of the stock in cars for each ton of freight; by m' the value of the time of all the hands in the train for one hour; and by q the number of tons of merchandize in the train.

The value of one hour for the whole train will be, at 6 per cent.

$$\frac{6}{100\,m}(\mathrm{F} + fq) + m'; \qquad \text{(L)}$$

and if we represent this quantity by H, the difference between the values of the velocity V' and that of V, will be for each ton, and for one mile

$$\frac{\mathrm{H}}{q}\left(\frac{\mathrm{V}' - \mathrm{V}}{\mathrm{V}'\,\mathrm{V}}\right). \qquad \text{(M)}$$

This is the difference per ton per mile to the company between the values of these velocities, where no imperative conditions obtain.

Now let us see what value this expression exhibits under different circumstances; and for this purpose we will put $\mathrm{F} = 5000$; $f = 100$; $q = 50$; $m = 8760$; $m' = \frac{1}{2}$, all which are very common values, and suppose, in the first instance, that the business of the line may be transacted by an adequate supply of engines, men and cars, at some exceedingly slow rate—as half a mile per hour—how much more would it cost the company, in the value of time, to carry the trade at this rate, than at a speed of ten miles per hour?

Equation (L) gives us

$$\mathrm{H} = \frac{11}{40} \text{ of a dollar,}$$

for the value of one hour of the time of the train. This value of H being substituted in equation (M) will yield,

$$\frac{11}{40 \times 50} \cdot \frac{10 - \frac{1}{2}}{10 \times \frac{1}{2}} = \frac{209}{20000} \text{ of a dollar,}$$

or more than one cent per ton per mile.

Now, in this case, the value of the time of the train, exclusive of the goods, is equal to half the actual cost of transportation on a well managed road with ample trade; and it is perfectly apparent that, even overlooking the loss of time and depreciation of the price of the *goods*, such a rate is wholly inadmissible. But let us apply the equation to the determination of the difference of value of a speed of five miles and one of ten miles per hour, under the same circumstances. In this case equation (M) gives us

$$\frac{11}{40 \times 50} \cdot \frac{10 - 5}{10 \times 5} = \frac{11}{20000} \text{ of a dollar,}$$

or only one half mill per ton per mile—or less than the tythe of the actual difference of cost—consequent on the destruction of cars, engines and track—risk of accident and damage to goods, incident to the adoption of the greater velocity.

The whole difference between the value of a speed of five miles per hour and one of ten miles per hour, will rarely exceed one mill per ton per mile, in its effect on the interest of the value of the train, together with the depreciation of the value of the goods conveyed. However great, then, may be the inducement to carry passengers at a more rapid rate, there is no sufficient cause for transporting freight at a speed of more than five miles per hour, unless, as already premised, a higher rate is absolutely essential for the accommodation of all the trade which is commanded by the line—a condition which, on ordinary roads in this country, very rarely prevails.

We are not likely to overrate the injurious effect, or too strongly to deprecate the continuance, of the mischievous practice which still prevails in this country in the transportation of heavy commodities. The iron rails are rapidly destroyed by it; the wear and tear of the cars and engines are greatly augmented, and the useful effect of the power applied is materially reduced. There is no corresponding advantage obtained. The value of the time which is saved is almost too small to be estimated for the freight, and the value of the time lost by the train bears no perceptible proportion to the injury which is done to the road and its furniture.

TO BE CONTINUED.

FOR THE JOURNAL OF THE FRANKLIN INSTITUTE.

Railways in Massachusetts. *By* ALEXANDER EVANS, *C. E.*

As the great system of railways in the state of Massachusetts is far advanced towards completion, we are not only gratified with the results of her enterprize, but we look to her for much useful and interesting information, derived from actual experience in the construction and working of her roads.

The following tables exhibit the length, the cost of construction, the cost of repairs and working, the receipt from passengers, freight, &c., and the net proceeds of the principal railroads in Massachusetts during the year 1841.

Table No. 1, exhibits the total number of miles run on eight of these roads, and the cost of running per mile; the cost of repairs of engines and cars, per mile run, and the cost of repairs of road per mile.

The cost of running includes all repairs to engines, cars, and superintendence, and all other expenses properly chargeable to the working of the road.

The cost of running trains on these roads varies from 65 to 107 cents per mile, the lowest being the Western road, and the highest the Boston and Providence, and Taunton branch, which cost the same.

It will be observed that the cost of running on the Boston and Providence road is 107 cents per mile, while that of the Boston and Worcester road, which is nearly of the same length, is about 88 cents; but the distance run on the latter exceeds that of the former, by nearly 67,000 miles.

The number of miles run on the Boston and Worcester road is given in the last annual report of that company, for eleven months only of the past year, or up to the 30th of November; but an approximate estimate of the number of miles run in the month of December, has been made from the income of that month compared with the income and number of miles run in the eleven previous months.

The total number of miles run on this road (adding for the month of December, as above,) from 1836 to 1841, inclusive—six years—is 785,427, and the total cost of running was $ 703,930, or about 90 cents per mile.

The cost of running on the Western road has been, for the last year, $65\frac{4}{10}$ cents per mile, and for the six months preceding, it was only $61\frac{19}{100}$ cents per mile.

The number of miles run on the Eastern road during the past year, was 191,209, and cost nearly 81 cents per mile.

Bringing the number of miles run on all these roads together, we find the total to be, for the last year, 850,251 miles, and the total cost of running the same, $ 717,587 dollars, or $84\frac{4}{10}$ cents per mile.

The cost of repairs of cars and engines, per mile run, ranges from 9 to 18 cents.

The cost of these repairs on the Lowell road, the past year, is 18 cents per mile; the excess over other roads may, probably, be in part attributed to casualties and extraordinary repairs.

The repairs for four years, from 1837 to 1840, inclusive, on this road, average $ 14,604 per annum; and for 1841 the amount was $ 22,644, showing an increase of 55 per cent.

By a reference to the annual reports of this company, there appears to have been a great increase of business the last year, and, probably, a much greater number of miles run on the road than any previous year.

The total number of miles run on all these roads, as before stated, is 850,251, and the total cost of repairs of engines and cars, is $ 109,-620, or nearly 13 cents per mile.

The cost of road repairs during the last year, for four of these roads, doing a large business, and which have been in operation several years, averages about $ 650 per mile.

On two of these, viz:—the Boston and Worcester, and Lowell, roads, a light rail was used in the original construction, the former weighing 38½ lbs., and the latter 36 lbs. per yard.

Experience has shown that these rails are too light for the heavy traffic of these roads, and the tracks are, consequently, defective, and expensive to keep in adjustment.

In the construction of a second track for these roads, a heavier rail has been adopted, and other improvements made which will, it is believed, considerably reduce the cost of repairs.

On the Boston and Worcester road, there were, at the close of the last year, 70 miles of double track, and the Lowell road has two tracks complete.

The average annual repairs of the Boston and Worcester, Boston and Providence, and the Eastern and Lowell roads, from 1837 to 1841, do not vary much from $ 500 per mile.

The repairs of the Taunton Branch, the New Bedford and Taunton, and Nashua and Lowell, Railroads, average nearly $ 200 per mile per annum, since they were opened for business.

In Table No. 2 will be found the length, total expenditure for construction, receipts for passengers, freight, &c., and the expenses and net income of ten roads in Massachusetts.

The cost of these roads includes outfit, buildings, and fixtures, or the total amount charged to construction up to the close of 1841.

It is proper to remark, that a part of the expenditure of several of these roads, during the past year, is not strictly chargeable to the

cost of operating them, but would with more propriety be placed to the account of construction and outfit.

These, in several instances, are large sums, and being paid out, or deducted from the earnings of the road, considerably reduce the net income.

Eight of the roads embraced in table No. 2, which cost an aggregate of over nine millions of dollars, pay seven per cent. on the capital invested, and the net receipts of several are from seven to nine per cent. on the cost.

The total cost of all these roads is over seventeen millions of dollars; a considerable portion of some of them, however, are not within the bounds of the state of Massachusetts.

The length of the Norwich and Worcester road is nearly sixty miles, eighteen miles of which are in Massachusetts, and the remainder in Connecticut. Nine miles of the Nashua and Lowell, thirty-eight miles of the Eastern, and twenty miles of the Boston and Portland, roads, are in Massachusetts, and the remainder in the states of New Hampshire and Maine.

Statement of the length, cost of construction, number of miles run, and the cost of repairs, of eight Railroads in Massachusetts, for 1841.

No. 1.

Name of Road.	Length in miles.	Average cost per mile.	Weight of rail per yard, in lbs.	Miles run during 1841.	Cost of running, per mile.	Cost of repairs of cars and engines per mile run.	Cost of repairs of road, per mile.
					$ cts.	cts.	$
Bost'n & Worcest'r	44½	53,360	38½ & 60	174,632	0.87 67/100	*14 60/100	714
Boston and Lowell	25¾	71,258	36 & 56	125,296	†0.83 66/100	18 072/1000	720
Bost. & Providence	41 17/100	43,284	55	107,638	1.07 8/10	11 818/1000	594
Western	117	44,744	56½	160,106	0.65 4/10	10 604/1000	
Eastern	56‡	40,182	46½	191,209	0.81 04/100	9 32/100	551
Nashua & Lowell	14½	26,207	57	43,515	0.87 7/10	18 988/1000	190
N. Bed. & Taunton	20	21 137	58	27,039	0.82 4/10	13 513/1000	170
Taunton Branch	11	22,727	58	20,816	1.07 8/10	10 82/100	171

* This includes an expenditure of $9,900 for new cars.

† This does not include $14,438 expended in taking up seven miles of track of light (36 lbs.) rail, and replacing it with heavy (56 lbs) rail.

‡ This distance includes Marble Head Branch.

Statement of the receipts, expenses, and net income, of ten Railroads in Massachusetts, for 1841.—No. 2.

Name of Road.	Length of road.	Cost of construction.	Receipts for passengers.	Receipts for freight, mail, &c.	Total receipts.	Expenses of Road.	Net income.
Boston and Worcester	44¼	2,374,547	190,097	120,710	310,807	162,998	147,809
Boston and Lowell	25¾	1,834,893	145,953	121,588	267,541	119,469	148,072
Boston & Providence	41 17/100	1,782,000	152,016	78,805	230,821	122,057	108,764
Western	117	5,235,026	113,842	68,467	182,308	104,806	*77,502
Norwich & Worcester	58 9/10	2,157,037	99,332	55,925	155,261	78,805	76,456
Eastern	56†	2,267,033	257,734	41,840	299,574	154,958	144,616
Nashua and Lowell	14¼	380,000	75,732	56,764	132,496	95,966	36,530
N. Bedford & Taunton	20	422,758	39,469	13,044	52,513	22,285	30,228
Taunton Branch	11	250,000	52,278	24,646	76,925	55,043	21,882
Boston and Portland		553,289	85,928	30,088	116,016	82,021	33,995

* This road was not opened to the state line until October, and to the Albany and West Stockbridge in December, 1841.

† This distance includes Marble Head Branch.

FOR THE JOURNAL OF THE FRANKLIN INSTITUTE.

Reply to the writer of the Strictures on the Report and Plans of the Engineer of the Albany Aqueducts. By W. McClellen Cushman, C. E.

In his article in the last number of this journal, the writer appears piqued to have his former effusions considered a harmless batch of fallacies, misstatements and suggestions "pregnant" with very little, if any, meaning—and the more so probably to have them *so proven in detail.* This last, however, can scarcely be looked upon in as favorable a light—for there seems another than the apparent object

evinced throughout this effort; which it is very obvious was intended *chiefly* to serve for (what in politics I believe is called) a "*white-washing*"—of the errors of judgment, fact, &c., existing in almost every sentence of his first critical production.

After opening with an extract calculated to mislead the reader, from an allusion in my last, the writer complacently proceeds to attribute his *own misconceptions* to "the ambiguity of the style of the report." This would seem, certainly, at the very best, a rather lame *argument* on a scientific subject; and were best answered, perhaps, by inviting the reader to compare the styles of our respective articles, and such extracts from the report as the public have been favoured with (of late particularly) by the critic's liberality. But admitting the argument to have no foundation in the egotism of the writer, I beg to enquire in what way it supports the *errors of fact, judgment, &c., volunteered* (of course unassisted by the report) by the writer and his council of "practical friends," as exhibited, in italics, in my reply?

I. The writer next accuses me of "a design to dispense entirely with fire engines!" I have no disposition to set this down as much of a mistake—but it was with short hose that I proposed to produce jets rising to within ten feet of the fountain level *in the elevated district in which the aqueduct terminates*, at which place the head was stated to be fifty-five feet. I have at no time entertained an expectation of being able to force up jets to the *same actual level above tide*, in the *low districts;* but to heights proportionably near it, having regard to the resistance of the air, &c., in abridging the height of jet;* which, however, it is almost needless to intimate, would always extend to elevations much greater than is strictly required for the successful operation of the jets, for the purposes proposed, *throughout such portions of the city.* All this was distinctly enough stated in my reply; and the experiments on the Croton Aqueduct happening just at that time, were adduced as full confirmations of the views advanced in my report—and especially as regards the jets in the upper quarters, where there must, of course, be the most difficulty. I have now before me the late report of the engineer of that work, in which he states, that the jets at Haarlem river rose to a height of 100 feet, which statement does not differ materially from that made in my letter.

More recently still, as at the late celebration, &c., have former trials been again and again confirmed by experiments at the same

* "By no manner of contrivance, however, can fluids be made to issue from a pipe, or any other orifice, with the full theoretic velocity due the head of fluid; and the motion of the jet must invariably be still further reduced by the resistance of the atmosphere in its ascent, after issuing from the orifice, or pipe. Both these circumstances modify considerably the height of jet." Report, page 4.

places, and even at the fountains in the city of New York, &c. Yet the writer appears to consider the *extended experience*, as regards jets, on that work, as not possessing any claims to confidence, in comparison with the *single trial* at Fairmount, which, as was previously shown, was made in *impracticable circumstances!* With due respect for the reputation of the author he quotes, (though without having had an opportunity of examining the principles of his formula,) I must be permitted to say authority can weigh nothing in the face of the *palpable experience* derived from this series of trials, made in *competent circumstances* and on a grand scale—which give full and repeated assurance of the soundness of the views advanced in my report.

The writer imputes (with a flourish) some fanciful discrepancy between the statements of my letter and those of the report, as regards the level of fountain head, &c., in different parts of the city. Now the level at which the fountain head was established, as explicitly stated in several passages of the report, was 260 feet above tide level; and the same fact is inferable at several other places, by the simple process of *addition;* and this head, or level of head, is of course common to all points within the city limits, to which the water shall be conveyed—and this, although the reservoirs which form the *actual* fountain head, are located at the Cohoes, ten miles from the city. The *effective head* at the city, or that which actuates the flow and determines the specific quantity of water deliverable there, is also very distinctly stated, at several places, to be fifty-five feet, and this of course refers more expressly to the particular point at which the *aqueduct proper* terminates, and delivering over its supplies to the city mains for distribution. These latter being, of course, all in communication with the aqueduct and under the influence of the *common fountain head* will give local jets of heights bearing a relation to the depression of their orifices below its level, &c. Much nicer *visionary faculties* than ordinary men possess were necessary, I think, to discover any thing incongruous between these facts and the statements in my letter—the substance of which was, that in the *low section* of the city (which is elevated but little above tide, and gives, consequently, nearly double the head at Haerlem,) we should be able to perform even much greater things, in the way of jets, than had been done at that place, and we certainly shall do this, notwithstanding "the pregnant meaning" of the "facts" and objections the writer has produced.

Not to cavil about an *actual* difference of fifty per cent. between the writer's present and former statements as to height of jet obtained at Fairmount, I have only to say, it was certainly no concern of mine

whether the writer did or did not obtain "such results as might have been expected" *by him;* and it became so at all, only because omitting the essential circumstance of the trial having been made with "a single ajutage of one inch in diameter," he still took upon himself, upon the strength of that "indirect fact," the responsibility of deciding upon the feasibility of my plans for applying the head of water as a power, to the extinguishment of fires; which plan had reference "to an appropriate orifice for the jets," the copiousness of the supply of water, and contains other evidences of *respect for the laws of nature.* How the writer could do this upon the strength of a *single trial* made in *violation* of all these indispensable requirements, unless by mistaking his "stubborn fact" for a "principle"—in other words by evincing that he had no knowledge "of any such requirements," is a question for the candor of the public to decide.

The influence of the ordinary consumption of water upon the head in *standing pipes,* as instanced by the writer at the Navy Yard in Philadelphia, is perhaps one of the peculiar features of the plan on practice in that city. At any rate the essential independence of the jets of this city, is insured by the *location* which I have given the line of the *aqueduct proper within the city limits;* and it does so by determining the order in which the different sections will derive their supplies. It is in this way that the ordinary supplies of the citizens will "go on at all times when it is required," without sensible restraint upon the jets.

I did not propose to rest the safety of the city "upon the possibility of catching fire in its inchoative state," (meaning, it is presumed, when a fire first breaks out.) The writer unwarrantably assumes an intention on my part of dispensing entirely with the use of ordinary hose. Quite the contrary: the system of "short hose attached to the hydrants," forms the means of producing "an almost instantaneous effect," before "ladders, lengthy hose and a competent force to manage them could be provided,"—but which, *on their arrival,* could also be *attached to the hydrants;* and co-operate just as at present; and serve for *casting on water* at all points and in all positions within the reach of moderate jets; and always for *delivering* water at every accessible point, up to the roofs of the most elevated buildings in any quarter of the city. Nor must the system of pipes "for domestic and economic purposes," capable of delivering water into the "highest chambers," and (with the surplus head) even *above* the roofs—be supposed to play an insignificant part in the general plan.

Such is an outline of the system contemplated; which, while it will relieve firemen from the almost super human efforts they are now required to make, *in forcing jets by means of engines*—and often even

then without the power of staying the progress of devastation—will at the same time be able to arrest even the most "considerable conflagration effectually and expeditiously,"—even could we suppose such conflagrations either probable or *possible*, with such means and appliances at hand.

The writer feels "impelled to the conclusion" that I *must* have meant to restrict the size of the orifice to one and a quarter inch, &c. Whether the impelling power in this conclusion is or is not attributable to the limited inventive powers of the critic, I leave for others to judge. He is, however, as greatly mistaken in this as in most other "conclusions" of his. It appeared to me a very easy matter to manœuvre short hose of even pretty large calibre, and with orifices as large at least as the body of the common hose; and having satisfied myself from some observation and an attentive examination of the results of Mariotte, and other experimentalists, that *with orifices approaching this size*, it was perfectly practicable, on this general arrangement, to throw up jets of the height contemplated in my report, I left the *exact size* to be determined by trial when the aqueduct should be put down—intending to use just that size which should prove to be just adequate to produce the required effect as local jets, —comparatively small orifices, &c., being practicable in the districts of inferior level, where the *supply* of water, &c., would be greatest.

III. As regards the "fatal doctrine of one-twentieth of an inch," &c., I must request whom it may concern (and every city and flourishing village in the Union is deeply interested in the means of obtaining *abundant supplies of pure and wholesome water*, on an efficient and at the same time economical plan) to recur to my late reply, to perceive at once, and clearly, that the *actual thickness* of metal assigned the conduit, was *more than adequate* to support, *permanently*, the head it will be required to sustain—the conduit at Haerlem river having been actually working, for months, under "less than the equivalent of one-fourth of an inch for a seventeen inch pipe," &c.

The writer, however, disdains to notice the *practice there*, with tubes of twice the size of those at Philadelphia, (thirty-six inches is, I believe, the calibre) and with every thing else on a much greater scale. The reader will look in vain in his last effort for any reply to, or notice of, this *decisive case* of practice—which was adduced in my letter to show the "error" of *judgment* under which he laboured, in regard to the "*real results* of practice," &c.—and this, although he appealed so unreservedly in his first critical essay, *to practice*, as the *only criterion!*

But a grand reason for finally settling upon this thickness in preference to any other, was not from any misgiving as to strength, but

that it was conclusively settled, in my mind, that castings of one-twentieth of an inch *could not be executed,* nor indeed of any *less thickness* than the *fourth* of an inch, except by actually enhancing the cost of the work,* which of course left no rational motive for adopting any higher dimensions. I was subsequently fully confirmed in the propriety of this opinion and decision, on consulting with founders of skill and experience—whose opinion on such a point merited every confidence.

On some future occasion I shall, perhaps, find a convenient opportunity to enlarge upon the relations which should subsist between the diameter and thickness of metallic pipes, in order to sustain a determinate pressure, &c., and the writer is assured that I will then find it quite easy to establish the adequacy of the least thickness stated in the report, as regards capacity to sustain a *working head of fifty-five feet;* and, consequently, its suitableness (with some allowance for unavoidable corrosion, &c., before being laid, and, perhaps, in the first stages of the operation of the works) for the purpose, but for the practical difficulty in the way of executing the castings—quite as easy indeed, as *I have been* successful in demonstrating by *practice* that the actual thickness of metal to be put in the conduit, viz. one-fourth of an inch,† is at least *more than is really necessary.*

In the mean time I beg to remind the writer that he has not been "good enough to define what degree of excess of thickness will always make pipes secure when they fail only at imperfections," and will now, if he pleases to accept easier terms, reduce the challenge simply to failure of sound castings.

Regarding "the contingencies from without," and the *theory* of the writer as to the mode in which he deems pipes to be injured by the pressure of the earth which covers them—even admitting that any engineer of sound practical views can be found to concur in this theory, remedies for such contingencies are so easy, in my view, as to make any objection founded thereon quite frivolous.

V. This appears to be nothing more than tautology—a repetition of part of the preceding article.

VII. It would be a sufficient reply to the writer's *theory* as to "the momentum not being kept up while the piston clears the dead points," &c., to remind him that the proportions and play of the pumps, and

* "I do not think, however, that economy would be consulted in reducing the thickness below one-fourth of an inch; although, of course, with this calibre, the pipe would, *as far as strength is required*, bear a reduction of its thickness." Report, page 25.

† "The Philadelphia conduits being two-thirds of an inch thick and the Albany one-fourth of an inch, the quantity of metal in the latter is five-eighths, or 62 per cent., *less;* which prodigious economy of the costly material of which they are made, it will be observed, is *exclusively* the effect of *plan.*

other members of the elevating machinery, are *all essentially different*—the works at Fairmount not having been taken as my model: and that a Watt, a Smeaton, or a Fulton, would most probably also have presumed so far as to differ with the writer in his *entire admiration* of the plan of the works at Fairmount; and would probably have preferred to draw pretty largely upon the reservoirs of their own genius and skill. But is it not true that the works at Fairmount have several pumps worked by one shaft, and discharging into a common main or force tube? If so, does not such an arrangement *virtually* annul the effect of dead points? The theory of the writer seems to me to *fail* entirely to account for the destructive effects observed by the superintendent of those works.

The writer seems not yet to have discovered that *the conclusions* from facts, practice, and experiments, are often very absurd and improper; or that there is a pseudo false philosophy of this description which is an extremely fertile source of "error." In this way has he, I think it probable, mistaken "*theoretical conclusions*" for "experimental results of a very significant character;" and although such results should not perhaps be entirely "disregarded," still *practical men* may I think be permitted, (without incurring the imputation of "not feeling a proper anxiety for the success of works committed to their charge) to credit them only for just what they are worth. *

* * * * * * * *

In concluding I must take occasion to say that any critical remarks made in my report, were quite general in their character—no particular work being specified; that none were made which could well have been omitted, or which were not absolutely necessary as arguments to show the propriety of the plans I proposed, &c. If, therefore, any thing unkind has been said, or "odious comparisons" made, in regard to the Fairmount works, or the city conduits, or any other work, in the progress of this controversy, the thanks are due exclusively to the writer of the criticism on my report,—who rendered the special allusions necessary for its proper and just vindication.

* The next paragraph in the MS. of our correspondent, containing personal remarks, which can have no bearing upon the question in controversy, has been omitted. Indeed it is to be regretted that better temper has not been displayed in the whole conduct of the discussion, since both of our correspondents, doubtless, look to the same result—the establishment of what they believe to be truth, and the cause of truth is neither aided by harsh language nor personalities. Com. Pub.

TRANSLATED FOR THE JOURNAL OF THE FRANKLIN INSTITUTE.

Practical Experiment made by M. Fourneyron, to show the superiority of a Turbine over an Overshot Wheel, both using the same quantity of water, and working under the same fall.

The second turbine which I established was not tried with the friction dynamometer; it was not necessary here to prove to the proprietor for whom it was constructed how much it returned of the power expended, but only to show, that to produce the same effect, it consumed less water than other wheels, and that it turned under water sheltered from the frost,* and was but little affected by variations of level.

For this purpose, the turbine was placed under the same fall that drove an overshot wheel, which had been established some years, and which worked with the required velocity the pistons of the blowing machines of a furnace, which my turbine also was to drive.

One wheel was put into gear, and the other disengaged, while the opening of the sluice gate was regulated so that the expenditure of water should remain the same in both cases.

The overshot wheel was run sufficiently long for its motion to become uniform, and the strokes of the piston were then counted. The turbine was then put into gear, the other being thrown out, and after having run some time, the strokes of the piston furnished by it, were also counted.

The following were the results:

When the blast of wind vented was under 13 or 14 cubic metres (489 to 594 cubic feet) per minute, the two wheels (overshot and turbine) to produce the same effect, consumed the same quantity of power, for the turbine had then a velocity, and a width of gate drawn, which were very small.

On the contrary, in proportion as the opening of the gate and the velocity increased, a greater blast was produced by the turbine than by the overshot wheel, all other things being equal. Finally, when the turbine worked under the influence of the conditions of its establishment, or those for which it was planned, the effect produced notably exceeded that of the overshot wheel with which it was compared, which was in good order and had been well constructed. This overshot wheel, a single arm of which weighs more than the whole of my

* The great ease with which the turbine of M. Fourneyron can be sheltered from the *effects of frost*, will be readily appreciated by all practical men, who have had the management of water wheels in a northern climate, for it is quite evident that either by running the turbine in a close forebay, within the body of the mill, or by immersing it at will to a suitable depth *in backwater*, (as was done by M. Fourneyron, with a fifty horse wheel, at Fraisans, in France,) this peculiar water wheel *may, with ease, be effectually protected from ice.* M.

turbine, (whose weight is only 80 kilogrammes, or about 180 lbs.,) *is not susceptible of producing a power greater than three-fourths of that of this small wheel,* as was ascertained by the maximum blast produced alternately by each.

To show the facility with which it works under water, we immersed it to a depth of $1{\cdot}\frac{20}{100}$ metres, ($3{\cdot}\frac{94}{100}$ feet,) when it continued not only to give the necessary blast, but also made the overshot wheel revolve in the backwater. This wheel, though it received no water from above, while the turbine made it turn, yet without load, and whilst receiving all the water it could use, it had difficulty in taking a velocity half as great as that communicated to it by the turbine.

I know that these experiments, if they were isolated, would not be conclusive as to the utility of the machine, but I had to address myself to the eyes of a practical man, who judged better by experiments of this kind than by the use of a friction dynamometer, of which he did not understand the application.

Desiring to demonstrate, by figures, the superiority of the turbine over the wheels usually employed, I proposed to him to submit it to the trial of a brake, before I constructed the larger one, (of 50 horse power, at Fraisans,) which he was about to order; but being satisfied as to the results, after a few months' observation, he no longer delayed to intrust me with the construction of the large turbine which I have recently completed.

Bulletin de la Société d'encouragement pour l' Industrie National.

Franklin Institute.

Address delivered at the close of the Twelfth Exhibition of American Manufactures, held by the Franklin Institute of the State of Pennsylvania, for the Promotion of the Mechanic Arts, October, 1842 *; by* A. D. Bache, *LL. D., Prof. of Nat. Philos. and Chem. University of Pennsylvania.*

The traveler in the deserts of Syria, resting at one of those few favored spots where the turf shows the presence of the refreshing well, and the date palm gives him shade, finds himself amid the ruins of a great city. Broken columns—architraves, and fragments of pediments half imbedded in the sand—heaps of ruins, indicating the former existence of massive structures, and deluding him with the idea that even now he may trace the extent and form of the space once occupied by the dwellings of men—all speak of the magnificence, the grandeur, and the vastness, of a great commercial capital. He is amid the ruins of Tadmor of the wilderness, Palmyra, the great commercial emporium of former days—now part of the greater desert. Here was once the entrepot of the commerce of the East and West, and here arose a city—as it were one vast temple to that commerce which linked together the far East and West.

Amid the lagunes and marshes at the head of the Adriatic, the gorgeous fane and splendid palace are reared, and the varied ornaments of a florid architecture are lavished to decorate the homes of the merchant nobles. The very difficulties of the site are made to contribute to luxury; no noise of wheels disturbs the quiet of home, or the hum of business on the Rialto, but the luxurious gondola glides silently through the vast canals which connect the distant quarters of this queen of the sea. Commerce has been again at her work. Civilization has advanced westward; and while Tadmor is crumbling, and the sands of the desert are gathering over its ruins, Venice is rising from the waters, the new entrepot of commerce between the East and West.

A new route is discovered, by which the products of the agriculture and arts of India are conveyed to Europe; commerce departs with prosperity in her train, and Venice is given over to the destroyer.

In the early periods of history these changes were few, their progress was gradual, like the slow changes of the scenes of a diorama; ages elapsed before the tide ceased to set through Palmyra. In modern times the changes are like those of the kaleidescope, sudden and striking. Agriculture changes its objects or its methods—manufactures spring up and flourish, or decay—the arts find new seats and new subjects for their exercise—commerce, which connects the producer and the consumer, runs in new channels. Cities greater than Tadmor or Venice spring up, the creations of a new civilization.

Increased production, whether in agriculture or manufactures, is so obvious and powerful a source of prosperity to a country, that we naturally look with interest upon every circumstance which may effect it, endeavoring as far as may be, to understand, that we may aid. While all are agreed as to the necessity for cherishing agriculture, manufactures, the mechanic arts, and commerce, as the essential elements of national wealth, few agree as to the means of protection. One would think that by this time facts enough had been accumulated to settle all doubts, and to establish a science whose principles should be as well ascertained as those of the philosophy of nature. But the passions, prejudices, and interests of men must be overcome before they desire to find the truth; and then all the difficulties remain of interpreting the results of complex experiments, and of assigning the just influence to each of their numerous and varied attendant circumstances.

It is conceded in every civilized community that the products of its agriculture, manufactures, and arts, should be brought as nearly as possible to perfection, and that improvement is the necessary consequence of the increased intelligence of those who follow the various callings connected with them. Avoiding, then, debated and debatable ground, and planting ourselves upon that which is fully and fairly our own, it may be profitable for us to consider *the means employed in different countries for the promotion of manufactures and the mechanic arts, and of the intellectual improvement of their cultivators.*

From this general survey, we may derive materials for a compara-

tive estimate of our own efforts—encouragement it may be, or stimulus to increased exertion;—hints of new lines of usefulness, or assurance that perseverance in those in which our efforts are already directed, will ultimately be crowned with success. In a country like this, where public opinion makes, alters, or repeals, the laws, there is always reason to hope for the success of what is right. It may not come this moment, nor the next, but as sure as the darkness of night heralds the approach of dawn, which certifies the coming noonday, so surely will truth finally prevail where public opinionrules.

The principle of voluntary association by which, in the United States, we obtain some of our best results, is derived from the country to which we owe our origin. It is imperfectly understood on the Continent of Europe, and is but feebly applied even in those countries where a semblance of political freedom exists. The government too often assumes the power to direct the mind and to control the will.

Prussia has undertaken to show what an "enlightened despotism" may effect, and the results of her combined educational, military, political, and religious system, yet remain to be fully developed. The rulers have had their preferences in regard to the encouragement of different departments of agriculture and the arts. At one time, the silk culture, and the manufacture of silk and porcelain, were especially patronized; at another, brass and iron founding, and the culture of the beet, and the manufacture of sugar from it. The minutiæ to which the government descends, may be perceived from the fact that licenses to follow trades and occupations, the results of which concern human life, (as those of the druggist and chemist, of the architect and builder, of the mason and carpenter, and even of the well-digger,) can only be had upon an examination upon certain preliminary acquisitions, deemed essential to the prosecution of each.

The recommendation of general measures for promoting the interests of the useful arts, is entrusted to a technical commission connected with one of the departments of the government. A society is also permitted in Berlin which takes cognizance of inventions submitted to it, which meets at stated times to discuss reports upon alleged inventions or improvements, and under the nominal patronage of which a monthly journal is published. To provide for the technical instruction of those who intend to follow mechanical employments, schools have been established in many of the provinces, to be entered after the usual period of elementary instruction is passed, and before an apprenticeship is commenced, or during its first years. The most promising pupils of these schools are transferred, after serving a portion of the time of their apprenticeship, to a central school, at Berlin, where they receive, free of expense, instruction in the branches which may fit them for the occupation of machinists, founders, and the like. Architects, builders, and engineers, have a similar public institution, for the preparation of the members of their professions. The Trade Institute of Berlin turns out annually a class of well educated young men, whose influence on the occupations which they embrace, must ultimately be of the highest benefit.

The plan and execution of that great scheme of uniting the States

of Germany, once loosely connected by political ties, in a commercial league, is due to Prussia, and now the toll-league embraces nearly all the States of the old German empire, except Austria. A uniform scale of duties is adopted by all, and import duties are collected at the frontiers, to be distributed in proportions agreed upon by the several parties.

Austria has *her* way of encouraging manufactures and the mechanic arts, different from that of Prussia. Her manufactures of porcelain, of iron, of linen, of sugar, and of chemical products, have in turn been aided. Her quicksilver mines and porcelain manufactory belong to the government, and the former are worked by a corps specially organized for the purpose. The government has established trade schools, like those of Berlin, in some of the provinces, but their great *Polytechnic Institution* is in the capital itself. No expense has been spared to collect in this establishment the best specimens of the materials used in the arts, of the tools and machines (or models of them) employed in the different manufactures, and of the products of industry. All are used for the purposes of instruction in the technical schools, and are accessible to the mechanic. One portion of the immense structure is occupied by the rooms devoted to these collections, and to models of architecture of various kinds and of different countries. In one of them is a model of that admirable structure, now lost to us, the work of an American mechanic, the wooden bridge at Fairmount; and it would be curious if one day a Philadelphian should bring back a copy of it, to place in the hall of the Franklin Institute of Pennsylvania.

The late emperor, when heir apparent, vieing with that department of the government which had charge of the polytechnic school, collected for himself a vast museum of materials and products of the arts, presenting not only the results of Austria, but of the world—a standing exhibition of the works of the useful and decorative arts.

The stranger must be struck with the magnificence of the pile thus reared by imperial munificence, as the temple of the useful arts—and as entering the spacious gates, he passes through the halls devoted to elementary instruction in science and languages, to the higher branches of practical science, through the laboratories only rivalled by one among ourselves, through the extensive range of rooms for the display of materials of the arts, of models, of fabrics, of machines—through the work-shop, whence some of the most accurate instruments have proceeded—through the immense galleries, devoted to a standing exhibition of the arts, manufactures, and agriculture of Austria—he cannot but admit that in *this* at least the government has wisely appropriated the means derived from the people for the people's good.

It is admitted by all, that in the arts depending upon chemistry the existence of that institution has already produced important effects, and it is generally believed that the view there afforded of the comparative essays of different manufactures has led to the improvement which the products of Austrian industry have exhibited at the German fairs.

Whether practical instruction in the workshop should precede or follow the theoretical instruction of the schools, is a moot-point. An intelligent iron master of Styria thought he had found the true solution to the problem, by bringing up his sons, from the time of finishing their elementary education, at the forge and furnace, and at the end of their apprenticeship sending them to the technical schools. On the contrary, the Prussian educates for the workshop in the school, requiring each pupil to go through a course of practice there—and in Dresden, the apprentices who are pupils of the Saxon Trade School, work during a part of the day, and receive their technical instruction during the remainder, thus mixing theory with practice.

We may admire the efforts of the Austrian and Prussian commissions, but after all, the plodding spirit of routine which clogs the limbs of activity in these countries, renders the measure of success of the plans *there*, no scale to judge of what would be accomplished where the load of despotism was not to be borne forward.

France has halted in her scientific career since the youth of the nation have drunk so deeply of the excitements of political life. In Paris, the periodical exhibitions of the manufactures of the kingdom, are doubtless not without their influence. The Conservatory of Arts and Trades—a fine array of models and machines—chronicles the various improvements in each branch of art. The lectures of its eminent professors spread before the student the scientific principles which he is to use. A few members in the National Institute give a representation to the arts. But these are acquisitions of a past day. The trifling public aid extended to the School of Arts and Trades in Paris—the stationary condition of the Sevres porcelain factory—the diminished glory of the Gobelins—the attacks in the Chamber of Deputies upon the Industrial School of Chalons—do not speak of progress in the old way of government support, and no new one has come into operation to replace it.

It would be easier to generalize in regard to the United States, extending as it does through twenty-six degrees of latitude and eighty-three of longitude, than in relation to the small territory of Great Britain. If an Englishman's house is his castle, his workshop is its citadel. The establishment of Bolton & Watt is not open even to strangers, and strangers may pass into many not accessible to townsmen. Keen competition keeps men much asunder.

The Manchester man would care little for an exhibition which would bring to his town the iron of Glasgow, or the cutlery of Sheffield. Besides, neither his customers nor his judges are to be found at home. Rodgers displays his cutlery in his shop, because all great manufacturers have a show room; but he looks to America for his gains, and his agent in London occupies a small shop in an obscure street. Mackintosh cares little whether the colours of his dyes suit the "Glasgow folk" or the "Edinboro' gentry" or not, and Strutt does not make his woolens for the consumption of Derby.

The home market is comparatively of little importance. Every man endeavours to improve as fast as he can, to surpass his neighbour—to keep, as far as he can, the ascendency which skill, or talent,

or capital may have given him. The attempt of the British Association at Newcastle to bring together the products of the arts and manufactures, was but very partially successful, and it was thought that if this had been made by practical instead of scientific men, it would have failed entirely.

Are we to infer from this, that exhibitions andcollections in the arts, and the diffusion of knowledge in regard to them, are all useless? England is the workshop of the world. To what purpose do we toil to promote that which can and will take care of itself? Let us examine this argument a little. Are we sure that things might not be better under a different system, even in England? Who shall say what progress the English manufacturers and mechanics might have made, had their energy been aided by greater publicity—by greater facilities for comparison? One thing may positively be affirmed, that no patriot would exchange the neglect of education on the part of many of their opulent mechanics and manufacturers, of self-improvement out of the immediate line of the workshop, of good manners and address, for the strikingly reverse trait which obtains among so many of our men of equal resources in the arts. Education make a mechanic! says the objector. Watt was educated a surveyor—Arkwright a barber—and yet the one was the great inventor of the useful form of the steam engine, and the other of the jenny. What use of schools for special instruction in mechanics? This objection might, perhaps, have some force, if all men were Watts and Arkwrights, if there were no *common* minds to train. It would have more force if there were no education but to make certain forms of letters, and to construct sentences, and to add numbers. Away with such limited views of education! Were Watt's powers of observation and reflection not educated? Were Arkwright's powers of invention not educated? Their lives show how *the circumstances in which they were placed educated* them for their very inventions.

But if this argument is worth any thing, it is worth carrying to its full consequence. Because Burritt was brought up a blacksmith, Lukens a farmer, Baldwin a jeweler, Merrick a merchant, and Morris a druggist, we should make linguists by putting our sons to the anvil, mechanicians by requiring them to follow the plough, builders of locomotives and steam engines and machine makers by apprenticing them to the details of filagree work, of accounts, or of pharmacy. This seems the legitimate inference from the argument of those who, because English manufacturers and mechanics are great in their lines, would eschew schools, lectures, cabinets and exhibitions. Ask the men themselves whom I have referred to, how *they* would desire to educate *their* sons—how they would wish to have been educated, were their lives to be passed over again. Hear from them the difficulties which they have encountered for want of a different schooling. Hear from them the circumstances which have really given them their schooling. The school of life and practice is one of the hardest in which men are educated. Men who are educated in it are planting in growing time, and may be considered happy indeed if they reap before winter.

But have no attempts been made in Britain to improve the mechanic as an intellectual being? Professor Anderson, of the Glasgow University, dissatisfied with the narrow regulations which constrained the institution to which he belonged, left by will his apparatus and a small legacy to found a more liberal school. Dr. Birkbeck endeavoured to make this small foundation available for the instruction of mechanics, and classes were opened for their benefit in the institution. Voluntary associations of mechanics, under various titles, sprang up under the direction of Birkbeck and his associates, and for a time promised great things in the culture of both the adult and the youthful mind. They usually combined public lectures in chemical, mechanical, and general science, and classes of mathematics, of English, modern languages, &c., for the sons, wards, and apprentices of members. Many of them are still in existence. Some have taken root, but are found to be supported more generally by merchants of various grades than by mechanics. From the example of these associations, others for very popular instruction have been established, giving lectures at moderate rates on geography, history, and the elements of natural science.

Some of the institutions for the promotion of the arts award prizes for special excellence in particular objects to manufacturers and mechanics, and also to the successful pupils of their schools. The Society of Arts of London, and that of Scotland, give premiums for meritorious inventions submitted to them; have papers read before them, by members, on new inventions, and the former association publishes its transactions. Each has a meeting for the public award of premiums. The Royal Institution of London, at its Friday evening meetings, calls frequently on mechanics for lectures, explaining their arts and trades, and the improvements in them. These and similar efforts contribute to diffuse and to increase knowledge. If the results seem to be small, lost in the great stream of improvement which ever flows onward; yet in mingling with it, they impart at least some small motion to its mighty mass. The collision of mind with mind that takes place in these numerous associations, is of high importance; the tendency is to make men aware of their own deficiencies and to furnish a motive to supply them, to liberalize the feelings, to promote mutual confidence, and to produce esprit de corps. These results are of inestimable value in the aggregate.

The low wages of operatives generally in Europe, low relatively to the prices of conveniences, tends to keep the mass of them from intellectual improvement. Their youth is passed before they can judge of the necessity for culture, and when manhood is reached, the cares of providing food and maintenance for themselves, and usually for a family besides, press upon them so heavily, that they have time to think of little else. Until the means of life are more uniformly distributed, the mass of the mechanical population of Europe cannot become intellectual. The advantages of a different system of things, which exists with us, we should never lose sight of—never let go. It is not true that the necessaries and comforts of life are higher with us in the same proportion as our wages. The life of the

American working-man is not that of the European. Besides that his inestimable political rights put him on a par as a citizen with every other citizen, he occupies a different place in the social scale—may, by education in school and out of school, put himself on an equality with any other citizen—and may have comfort and competence for himself and his family. Thus relieved from the grinding pressure of want, wo to him if he slight the privileges bestowed by a bountiful Providence! Wo to him if he forget that he has a mind and soul as well as a body—an intellectual and moral as well as a physical nature!

Which of all these plans, devised by the intelligence of so many minds, for the *improvement of the useful arts, and of their cultivators*, have we followed out? What new paths have we opened? What success has attended our exertions? Voluntary associations for the improvement of agriculture, manufactures and the arts, exist all over our country, not supported, it is true, by our great sovereign, the people, but by a few, who are either immediately or remotely interested, or who desire to advance the weal of their country. If the eyes of this most august sovereign might but be opened to the importance of fostering these institutions! If for the improvement of the mass, he would but contribute a little of what he lavishes in raising up the political princes of the land! In the olden time, the commons of England gave every ninth sheep and every ninth fleece to their ruler, to enable him to wage war; now a large portion of our commons devote at least the ninth penny to king Party, to enable him to carry on the strife political. Would that they would spare the ninth part of this to put down ignorance and elevate virtue!

In different parts of our country, the modes of action intended to accomplish the great ends to which I have referred, have been various, and attended with very different degrees of success. It will be more proper, as well as more profitable, to look specially to our own doings.

What have *we* done to advance the progress of the useful arts? First, what have been the results of our exhibitions? The same which experience all the world over has shown to result from them. But will it be said by any one, however enthusiastic, that the contrast between the meagre show in the Carpenter's Hall, at our first exhibition, in 1824, and the brilliant display which is just now terminated, is due to these exhibitions, or to those in Philadelphia, New York and Boston, combined? Let us reply by another question. Would we, or would we not, have arrived at the same point without these annual or biennial shows? I answer unhesitatingly, No! It has been remarked of exhibitions of specimens in the arts elsewhere, that though the same artists produce the specimens, there is a steady improvement in them. The taste of the public is improved by them—the taste of the artist is elevated. So, here, observe from year to year the growth in taste of the judges of the different articles submitted at the exhibition, and of the depositors, who are the venders of the manufactured articles. What a powerful reaction must be produced by thus furnishing the vender with the means of accurate comparison, the conclusions from

which he may communicate to the manufacturer. Observe the public generally, how the admired articles of one year are the rejected of the next! Listen to the remarks made upon those branches of industry which are stationary. To deal with history instead of what is present; turn to the exhibition of two years ago. Take a branch of manufacture then dead, and compare the effect produced by the well preserved mummies of specimens, though carefully washed and well placed for show, with the results of their first living appearance. The glazing and gilding are untouched, the colours of the painting are as bright as ever, the designs just as tasteful as they were when first exhibited; but the taste of the public is improved, the specimens are returned to their cases, their interest for the future is purely historical —they are deposited among the archives of the arts. The influence of this improvement in public taste alone is not to be rejected.

It is obvious, then, that there are reasons why exhibitions should contribute to *aid* that which requires other causes to support. If they neither form the foundation of the building, nor yet its superstructure, they serve to determine its shape and the arrangement and distribution of its parts.

The influence of the medals and certificates awarded at these exhibitions is much undervalued by many, who, looking merely at their intrinsic value, consider them as so much silver or paper. They would value in the same way expressions of esteem as so much breath. The great dramatist has sufficiently held such persons up to ridicule by putting their argument touching honour in the mouth of that impersonation of all that is ludicrously contemptible—Falstaff. These testimonials have, however, a value in dollars and cents, which, though *I* cannot precisely estimate it, others may. Those who know enough to be aware of their own ignorance, look to others who have knowledge to guide their opinions. Thus the opinions of the judges, expressed at the exhibitions, become the guides of many and many purchasers, who seek or reject, not according to their own judgments, but according to the decisions of the Institute. Rely upon it, these exhibitions and the premiums awarded at them, have a powerful action upon the consumer, the vender, and the manufacturer, and through them upon the arts.

These periodical exhibitions are times of high excitement in the Franklin Institute. The public is called in, and the members are their entertainers. The fly-wheel of the institution appears to have been thrown out of gear, and the motion is rapidly accelerated. It could not exist under a long continued action of this sort. Why should not provision be made in the ordinary and regular working of the Institution for a constant exhibition? Why should all these products once collected be dispersed, never again to be re-united? Like the Conservatory of Arts, of Paris, or the Trade Institute, of Berlin, we should find such a collection a chronicle of the history of each art in our country. As in the Polytechnic Institute of Vienna, we should find by the side of models and machinery, the raw materials and products of our manufacturers and arts, from the date of their introduction, or use,

to the day of exhibition. Were our *Sovereign* prepared to erect the piles of the Conservatory or of the Polytechnic school, we should easily find articles to fill their ample halls,—and is it impossible that this should ever be? Look at the structures raised by the public for education. Who would have believed forty years ago, that such would now exist by the means which have raised them? Voluntary association may do much, but not everything. The desire to accomplish this, among other purposes, led to the attempt to extend the accommodations of the Institute in 1835. Perhaps under other circumstances we might have succeeded. Had the tide continued to rise, instead of beginning to fall, we might have passed the shoal, and found ourselves in smooth water on the inner side. We may now be satisfied that having ventured much for a great good, we are still safe. This branch of our Institute must bide its time. Meanwhile, the exertions of the Professors and members are forming the nucleus of cabinets of models and products of the arts, which promise to become of value; and the steps taken by the Managers to obtain from depositors specimens of those articles which take premiums or certificates, where the nature of them admits of it, will, if met in the spirit of liberality by the contributors, soon secure a useful and large collection. How interesting a view would have been presented of the progress of American arts, had such specimens been collected at all our Exhibitions! And while on this theme, does not memory call before us one dear to the Institute, as among its earliest friends, its founders, its first Professor of Chemistry, who made the earliest beginning of our cabinet of arts and manufactures, whose zeal and judgment connected him with our best and most useful efforts—though removed from us by death, he lives in our affections, and his name will be perpetuated in the history of our Institution. We already begin to have a history. Already the obelisk is raised, upon the base of which the names of the useful, zealous, and able, among the members of the Franklin Institute, are to be inscribed at death—that tablet bears even now the names of Keating and of Ronaldson.

The awarding of premiums for inventions, though distinctly different in part of its operation from similar awards for the best specimen of any art, owes its efficacy to the same principles. It is not the value of the prize, but the value of the opinion, which causes the inventor to submit his designs for examination. This consideration of inventions forms part of the everyday business of the Institute. Formerly it was done by the Committee on Inventions, and now by the Committee on Science and the Arts, formed by the voluntary association of the members of the Institute. The time and capital which have been saved to projectors, and to those who furnish them with means, through this Committee, are not the least important of its results. Men who were flattered at home with the idea of being Fultons and Watts, have found that, after all, Fultonism is not so easy of attainment, and those who were prepared to embark their means in schemes, have been saved both money and chagrin. Our countrymen are yet favored, occasionally, with the *novel and astounding* sight of vessels torn to pieces by the destructive agency of gunpow-

der, fired by the also *novel* method of a wire, heated by means of a distant galvanic battery—and all at the expense of the United States. With the explosion of unexplodable boilers, or of some old fashioned way of preventing this catastrophe. These things merely indicate, perhaps, a plethora in the National Treasury, or, perhaps, that all knowledge is not given instanter, upon being elected even to high political stations. But, seriously, the award of the Scott's legacy medal and premiums, which our City Councils have delegated to the Franklin Institute, is the source of much usefulness, and, coupled with the opinions given by the practical and scientific men who are united in the Committee of Science and the Arts, has worked good to the arts, their cultivators, and their patrons.

In nearly all the institutions abroad to which I have referred, the publication of a journal in which to record inventions and improvements in the arts, and discoveries in the sciences which bear upon them, is regarded as of high importance. It is obvious, indeed, that this is the only effectual mode of diffusing a knowledge of improvement over a wide space. In days gone by, the mechanic of Continental Europe passed part of his apprenticeship in wandering from place to place, to practise his art, as a means of support, and gathering the improvements which might have been made in it, to turn to account on his return home. Now the Journal brings to his door the improvements of the most distant places, with all the rapidity which steam navigation and railroad transit can give. There can be no doubt that of all the means of usefulness of the Franklin Institute, the publication of its monthly Journal is most widely operative. Its readers find a chronicle of the ingenuity of our country in the patents recorded in its pages, while they find the wheat separated to their hand from the chaff, winnowed by the labors of one who brings knowledge unsurpassed in this department to the execution of his work. Copious extracts from foreign journals convey the improvements of Europe to our mechanics and manufacturers, while original articles from our own mechanics, engineers, and men of science, contribute their full quota to the interest and usefulness of the work. It was early determined by the Institute that such a journal must be maintained, and the present periodical, originally commenced by the Professor of Mechanics, was adopted. The expensive nature of the work, its low price, and the limited support which it was likely for many years to receive, forbade the idea that it would be a money-making undertaking; and the Institute has been satisfied to support it, as a means of usefulness, at a small annual loss in money. But, for a feature characteristic of the enterprizes of the Franklin Institute, there can be no doubt that this undertaking would have been onerous. Whenever a line of labor likely to benefit the public has been pointed out, and a scheme for rendering it available has been well matured, members have been always found willing to devote their time to its successful execution. It is thus that men engaged in laborious occupations, in which their time and talents are money, have devoted themselves, day after day, to labors enjoined by the Institution, without looking for any other reward than that of being useful. It is thus

that the pages of our Journal are supplied with materials, original and selected, (some requiring the labor of translation from foreign languages,) by the generous labors of collaborators, whose zeal is tried by the monthly repetition of its exercise. With all these resources at command, the Institute is still obliged to look to the benefit of this work to the mechanic, as a motive to support its expense, and to wait, in this as in some other enterprises, the time when a greater intelligence in our country at large, and increasing resources, will fully repay the pecuniary outlay annually made.

One branch of the labors of the members of the Franklin Institute has, I believe, no precedent in any similar institution—I mean that of original investigation and research. The Institution thus aids to advance as well as to diffuse knowledge. Of the experiments of the Committee on Water Power, one of the highest living authorities (Mr. Rennie) has spoken in terms of the highest praise. The results of the experiments on the explosion of steam boilers have contributed strongly to turn attention away from imaginary sources of danger, and to fix them upon real ones. The conclusions from some of the more refined and difficult experiments, are quoted in quarters which cannot be suspected of either local or national partiality. These various researches, together with those on the strength of materials, must ever remain a monument of the industry and zeal of the early members of the Franklin Institute. They furnish a claim to public favor and support that no similar institution can justly put forth.

From these extended schemes, in which the members of the Franklin Institute are only incidentally partakers with the public in the common good effected by their instrumentality, let us turn our attention to the special means of promoting the mechanic arts, through the intellectual cultivation of those who pursue them. In the infancy of science, every experiment led to a discovery, and the art offered a scarcely less fertile field than science to their cultivators. Now discoveries in science and improvement in art, are the result of well directed trains of observation, experiment and thought. To direct these, the arts call in the aid of theoretical science. Besides the general cultivation of mind to be derived from pursuing any branch of knowledge, in the sciences of mechanics and chemistry are to be found those principles which alone are safe guides to improvement. It will, perhaps, hardly be believed, but it is, nevertheless, true, that not ten years since there lived in our city an ingenious man, who wasted his time and substance, and the resources of his family, in a pursuit after the perpetual motion. How many such disastrous results are prevented from year to year, by the application of principles taught in the lecture room, may be inferred from the number which require the additional nipping action of the Committee on Science and the Arts. Besides, the lectures upon mechanics and chemistry, which constitute the frame-work of our system, the filling up of architecture, mineralogy, geology and mining, has been supplied by the voluntary contributions of members distinguished for their knowledge, and for their powers of communicating it; and even kindred branches of na-

tural history have been, from time to time, furnished from similar sources.

It has always been the liberal policy of the Franklin Institute, while retaining the control of the institution where, from its nature, the control should be retained—in the hands of mechanics—to call in the talents of other professions to their aid. While by the constitution, two-thirds of the Board of Managers must be manufacturers or mechanics, every citizen is free to become a member. No co-operation is spurned; and in return, knowledge, time, and talent, of various kinds, are at the disposal of the foster mother. This same liberal principle of action shows itself in the very moderate requital expected for all the privileges bestowed, by which membership in the Franklin Institute is placed within the means furnished by the deposit of one cent for each of the working days of the year. Exclusiveness is absent from each and every department of the Institute, and to a degree which, to those who believe such establishments are raised and must be used for the benefit of certain cliques, and the propagation of certain individual influences, is almost startling. What would be thought of raising a voluntary committee of the members of an institution, the annual contribution to which of three dollars makes a member, to consider important inventions and improvements in the arts. Such a thing, the advocates of cliques would say, must lead to confusion. A voluntary committee is wholly uncontrollable—and so it should be. Just such a committee—just so uncontrollable—has existed and flourished in the Franklin Institute for several years, every member being at liberty to join it who is willing to perform the labour required of him. I do not think I overrate the importance of this association of members, when I place it next to the lectures. The library and reading room are no doubt more extensively useful to the members; but the knowledge acquired from books and experience, which is called into action in such various ways, and on so many occasions, in the Committee on Science, and the opportunities for intellectual culture afforded by calm investigation, by cool, but earnest, discussion, and by the appeal to experiment, are so practically improving as to rank above all passive means of cultivation.

Besides the Lectures, the Library, and the Committee on Science, the Monthly Conversation Meetings serve as rallying points—as opportunities of giving instruction or of being instructed in the scientific or mechanical novelties of the day. In a large metropolis like London, it is always possible, during at least a part of the year, to obtain materials for even weekly meetings of this sort. At the Royal Institution of London, there is an informal lecture at least once a week, corresponding somewhat to our Conversation Meeting. If we could concentrate here the novelties which in our country find vent through various channels, we should be able to carry on these meetings with more spirit than is now done. In the meantime, they are often both agreeable and useful, and, doubtless, will be kept up with occasional intervals.

While thus providing for the improvement of its members, the Franklin Institute has not forgotten their families, their wives and

daughters, as well as their sons, wards, and apprentices. When the lectures of the Franklin Institute first commenced, ladies were not in the habit of attending lectures—in other words, custom most ungallantly excluded them from opportunities of intellectual amusement and advantage. The Institute has turned custom out of the doors, and taken the ladies within them.

A series of schools for youth at one time entered into the plan of the institution. Of these, the drawing school alone is still kept up with an efficiency and advantage which command patronage. I have very little doubt that had not public education taken the new position it now occupies in our city, these designs of the Institute would have been extended. The sovereign has now awaked to the advantages of supporting public schools by public means, although not yet fully prepared to push the principles upon which they are based to their utmost limit.

Among all these means of usefulness, there is no School of Commerce and the Arts like the Polytechnic Institution of Vienna, no School of Arts and Trades like the Berlin Institute, no School of Arts and Manufactures like the Paris Institution. The establishment of a School of Arts has been a favourite project with the Franklin Institute, but thus far has scarcely passed beyond a project; at one time on the point of receiving aid from the Commonwealth, at another almost put in operation by individual enterprize. This object requires means, and these we have not at our disposal. Will public opinion ever so far ripen as to furnish these means? This is an interesting inquiry. I have heard it remarked by more than one person conversant with the minutiæ of the institutions of Philadelphia, that all the enterprizes for the diffusion of knowledge are supported by a small portion of our population; and yet they are intended for the ultimate good of *all*, and should be supported by the *whole community*. There was no doubt a time when the idea of paying for the support of a fire department would have seemed preposterous, and now we quietly pay for insuring our houses, and then in addition, a portion of our taxes goes to furnish the means and appliances for extinguishing fires. What would we think now of supporting a fire department entirely by voluntary contributions? So public opinion oscillates from one side to another. What is at one time impossible, at another is firmly established as the general usage. Where shall we draw the line between that which is to be supported by general assessment, and that by particular contribution? *Shall the principle be that, what is for the good of the whole, shall be supported by the whole?*

It has been long established that the poor must be instructed at the public expense. It is found *cheaper* to educate the masses than to pay for the fruits of ignorance. Besides which, christian charity cares for the souls as well as the bodies of men. But the scheme of public education, free to all, is, even now, and in our own country, very imperfectly understood. Indeed it may be doubted if the public are yet prepared fully to follow it to its consequences. We began, in this country, after the example of the old world, to endow institutions for higher education, universities and colleges. Then we found that this

was beginning to build the house at the top. We turned and established schools, common schools, and occasionally a high school. And now the foundation and superstructure have no connexion. Is not this all wrong?

If we want precedent for a different state of things from the old world, we can find it, and so be borne out by experience, as far as institutions trammelled by feudalism can be guides to us. The so-called University of France includes all public instruction within its organization; the highest and lowest are free; why not the middle? why not all?

But it may be said we agree that that which shall benefit all shall be supported by all. We agree that education shall be put upon a *truly republican* basis, that all the schools, from the lowest to the highest, shall be supported from the public purse, that a wider range shall be taken than now in education, and yet the whole shall be supported by the public. But you go further, you ask that institutions for the benefit of certain classes, by name merchants, manufacturers and mechanics, shall be supported or subsidized from the public purse. These classes certainly, in my view, make up no small or unimportant portion of our community. They are surely not so few in numbers, nor so insignificant in influence, that their interests may be overlooked.

But I would go beyond this, and include in one wide system all the institutions of every name for the promotion of knowledge. It is not necessary to weigh their relative usefulness. It would be easy to bring up an array which would include all classes of our community. The Mercantile Library has its objects, the Apprentices' Library others; the Philadelphia Library, the Athenæum, the Philosophical Society, the Academy of Natural Sciences, the Philadelphia Museum, the Athenian Institute, and many similar associations, each and all have their spheres of usefulness. Take them together, do not their objects include in their range the interests of every citizen of Philadelphia? Are they not intended for the benefit of classes which include all? Would not good done to all of them be done to the whole community? If not, let others occupy the vacant ground. Nor would the difficulty of adjusting claims be an insuperable one. For such it never has been in any country where such a plan has been in fact executed, and executed it has been in many, though not perhaps systematised. What, for example, is the support of the Polytechnic School of Vienna, and of its Conservatory, from the public purse, but part of such a scheme? and just such a part as the subsidizing of the Franklin Institute, under its present organization and management, would be. What the establishment of a Museum of Natural History and of Coins and Antiquities, but the support of the Academy of Natural Sciences and the Museum? What the support of a Royal Library but that of the Philadelphia Library? All of these, or nearly all, every where, are under different boards of administration. The scheme is not so Utopian as, at first sight, it might appear. Our schools, colleges, universities, institutes, museums, academies, associations, under whatever name, for the diffusion and advancement of

knowledge, constitute an assemblage of objects, embracing within its scope all classes and all interests. Let me commend to your thoughts the idea of forming *a system* from these various parts, not centralized, but like our own political union, each independent, while all are united, *a great system of public instruction, worthy the patronage and support of a free and enlightened people.*

If public opinion were once right in regard to it, the details of the plan would present no serious obstacles. I have just read that a munificent Englishman has left nearly half a million of dollars to two institutions connected with the University of Oxford. Perhaps liberal individuals among us may one day turn their attention to the beginning of some scheme of general secular instruction, required imperiously in aid of moral and religious culture, by the nature of our political institutions. Without intelligence, virtue is comparatively powerless; without virtue and intelligence, liberty degenerates into licentiousness, independence into brutality. Liberty and independence exist but in name. When virtue, liberty and independence fail, the commonwealth which has chosen them as her watchwords, and has emblazoned them with the emblems of agriculture, commerce and the arts upon her arms, will cease to have a being.

COMMITTEE ON SCIENCE AND THE ARTS.

Report on Babbitt's Soft Metal Boxes.

The Committee on Science and the Arts, constituted by the Franklin Institute of the State of Pennsylvania, for the Promotion of the Mechanic Arts, to whom was referred for examination the Manner of Lining Boxes for Axles, Gudgeons, &c. with Soft Metal, invented by Mr. Isaac Babbitt, of Boston, Massachusetts, REPORT,

That they refer to a former report, made in September, 1840, for a description of Mr. Babbitt's improvement. The favourable opinion expressed in that report has been confirmed by experience, and the superiority of the "anti-attrition metal" over common composition for bearings, fully established.

The advantages of this application of soft metal are, 1st, greatly increased durability of wearing surfaces; 2d, diminished friction; and 3d, reduced consumption of oil;—to which might be added the comparatively small cost of both time and money incident to relining bearings when worn out.

Mr. Babbitt exhibited to the Committee some very satisfactory certificates from companies and individuals who have used his boxes, attesting the saving of oil effected, and the greatly reduced wear of the machines, by the substitution of the anti-attrition for composition or gun metal.

The Committee believe this invention to be highly useful and important, and therefore they recommend the award of the Scott's Legacy Premium and Medal to the inventor.

By order of the Committee,

April 14th, 1842. WILLIAM HAMILTON, Actuary.

Report on Naglee's Railway for Short Curves.

The Committee on Science and the Arts constituted by the Franklin Institute of the State of Pennsylvania, for the promotion of the Mechanic Arts, to whom was referred for examination a plan of a Railway for Short Curves, invented by Mr. Henry M. Naglee, Civil Engineer, of Philadelphia, Pennsylvania, REPORT,

That in Mr. Naglee's plan the inner curved rail is formed of a common flat bar or edge rail, without a groove, while the outer rail is composed of cast iron segments, with a surface three inches in width, inclined or bevelled inwards and downwards, and containing on the outer edge a flat rim, raised one inch above it, and two inches wide.

By this arrangement it appears that the wheels are kept within the rails by their flanches, as in ordinary roads. The inner wheels always move on their treads. As to the outer ones, since by the motion in the curve the wheels are thrown towards the outer rail, the flanches ride upon its bevelled surface, and may rise higher and higher upon it, until they are checked in this lateral motion by the rim.

A short curve of this kind has been laid at the Willow street depôt in Philadelphia, and has been seen by several members of the Committee in successful operation. Indeed it contains the essential condition of success—namely, that the car is constrained, by the mechanical bonds with which it is confined, to pursue the path marked out for it. All the other plans in use for turning short curves (viz: Stimpson's, Malcom's, and the common track,) have this indispensable character, and with it all succeed, and seem to operate *almost equally well.*

Great importance, indeed, has been attached to the device of virtually increasing the diameters of the outer wheels, by making them rest on their flanches, and thus bringing into action what is called the "conical principle." And it is, certainly, true that if a single pair of wheels, of different diameters, firmly attached to an axle, were to roll freely over a plane, they would move in a circular arc, the centre of which would be the point in which the line of the axle produced would meet the plane. But in every practical case, there are at least two pairs of wheels, attached to axles parallel to each other; and the curves in which they would severally move, if alone, having different centres, cannot possibly be described at the same time. Hence it is evident that when wheels of different diameters are attached to parallel axes, they cannot move at all, either in straight or curved lines, without some of them sliding. There may, certainly, be less sliding where curves are described, with the outer wheels of greater diameter; but if any advantage be thus gained, it does not seem to be of much practical value.

The most usual position for railways of short curves is in the public streets, where they are used for turning corners, or for leading into depôts. In such situations, it is a matter of great importance that the curved ways should be so constructed as not to interfere with the safe passage of common carriages and horses. One of the conditions re-

quired for this object is, that the rail be placed as nearly as possible upon a level with the street, and in this case, when the wheel moves on its tread, there must be a grooved depression along the inside of the rail, to admit the flanch. In the plan under consideration, no such groove is admitted, and hence even the inner rail must be sufficiently elevated to keep the flanch above the pavement of the street. As to the outer rail, its elevation will be still greater, in consequence of its bevelled surface and its raised rim.

The Committee do not feel called upon to consider the much agitated question of the comparative merit and originality of the different plans devised for turning short curves on railroads; but, having presented whatbelieve they to be a candid and correct view of the construction and action of that submitted to them, they here close their report. By order of the Committee,

August 11*th*, 1842. WILLIAM HAMILTON, Actuary.

Report on Hill's Occultator.

The Committee on Science and the Arts, constituted by the Franklin Institute of the State of Pennsylvania, for the promotion of the Mechanic Arts, to whom was referred for examination the model of an Instrument for Calculating Occultations, invented by Mr. Thomas Hill, of Cambridge, Massachusetts, REPORT,

That they have examined the model of Mr. Thomas Hill's Occultator, together with his demonstration of the principles on which it is constructed and used; both of which are entirely satisfactory, and show that by the use of the Occultator, without a table of logarithms, and with the elements given in the Nautical Almanac, or still more convenient, with those of Downes' United States Almanac, the time of beginning and end of an occultation or eclipse may be found with sufficient accuracy for practical purposes. The instrument must be highly useful to those who are desirous of observing occultations, and are not familiar with the use of logarithms and trigonometric formulæ. They would merely remark that instead of the moon's true hour angle and declination, it would be more precise to use those of the star in case of occultations. The model and process are founded on true geometrical principles, and furnish, in the opinion of the Committee, a new application of those principles, and an original inven tion of an instrument called the Occultator. They respectfully recommend to the Committee on Science and the Arts to advise the bestowment of one of the Scott's medals on its highly meritorious inventor.

By order of the Committee,

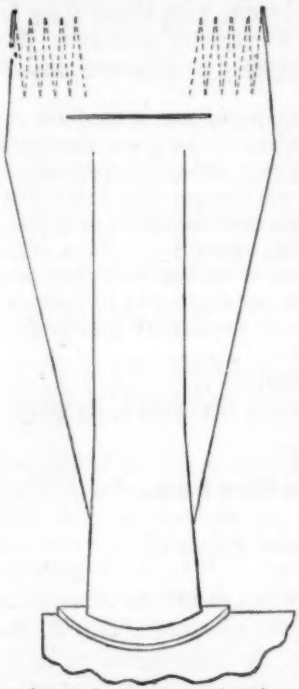
October 13*th*, 1842. WILLIAM HAMILTON, Actuary.

Report on French's Spark Arrester.

The Committee on Science and the Arts constituted by the Franklin Institute of the State of Pennsylvania, for the promotion of the Mechanic Arts, to whom was referred for examination a Spark Arrester for the Chimneys of Locomotive Engines, invented by Mr. Richard French, of Philadelphia, Pennsylvania, REPORT,

That this contrivance for preventing the emission of sparks from

the chimnies of locomotive engines, consists of several broad hoops of sheet iron, in the form of conical frustums, placed so as to encircle each other, and riveted together at the edges, so as to form a series of concentric annular spaces, and to afford a large surface of sheet iron within a moderate circumference. This sheet iron is perforated with a great number of small holes, about one-sixteenth of an inch in diameter, punched inwards to prevent their clogging with soot, and affording in the aggregate an area of opening several times greater than that of the chimney, which is enclosed by the sheet iron case that carries the spark arrester.



If the chimney of the engine be one foot in diameter, the surrounding case, at its widest part on a level with the top of the chimney, may be three feet; and, with nine concentric perforated hoops, each of ten inches or a foot in breadth or height, an area of sheet iron for perforation may be obtained equal to fifty or sixty square feet, which is an ample allowance. A central space, fifteen inches in diameter, directly over the top of the chimney, is left open, for a standing draught, and permits the smoke to escape when the engine is standing. Five inches above the top of the chimney, and three inches below the bottom of the perforated hoops, a circular plate of iron, nineteen inches in diameter, is placed horizontally, which prevents the sparks, when driven upwards by the blast, from escaping through the open space in the centre of the top of the case—which arrangements will more fully appear by inspecting the above diagram. The circular chamber between the chimney and the external case, forms a receptacle for containing the sparks; out of which they pass through an opening made for the purpose. The flat plate above the top of the chimney, prevents the direct action of the blast against the perforated iron, and reflects a large part of the sparks and cinders, so that they fall into the receptacle by rebounding from the plate.

The best test of the utility and efficiency of a spark arrester, is long-continued experience. Mr. French's contrivance has been in daily use upon the Philadelphia, Germantown, and Norristown Railroad, for nearly a year, on three of the locomotives, and has given great satisfaction in arresting the sparks without stopping the draught, being found much superior to several others that have been tried, the fuel used being pine wood. When the engine is running with the fire box full, no sparks are seen; when fuel is added, a few may escape, and when near the end of a trip, a few brands only remain on the

grate bars, the most sparks find their way out, but they are so small as not to cause danger. Although more or less dust escapes with the smoke, there is nothing which burns the clothes of either the conductors or passengers.

The present spark arresters have five hoops, with about forty feet of surface, and holes one-sixteenth of an inch in diameter. It is thought that less dust will escape if the surface is increased and the size of the holes diminished.

Those who have traveled much on many of our American railroads where pine wood is burned, are aware of the great annoyance of the sparks, particularly in warm weather, when the windows of the cars are open; and on some lines, the engines are followed at night by a fiery trail of great length, which, however beautiful an object to the spectators at a distance, is anything but agreeable to those within its reach. Mr. French's contrivance is one of the best and most durable devised for abating this nuisance; it is not expensive to construct, and is well worthy of the consideration of gentlemen interested in railroad transportation.

By order of the Committee,

September 8th, 1842. WILLIAM HAMILTON, Actuary.

Mechanics' Register.

SPECIFICATIONS OF ENGLISH PATENTS.

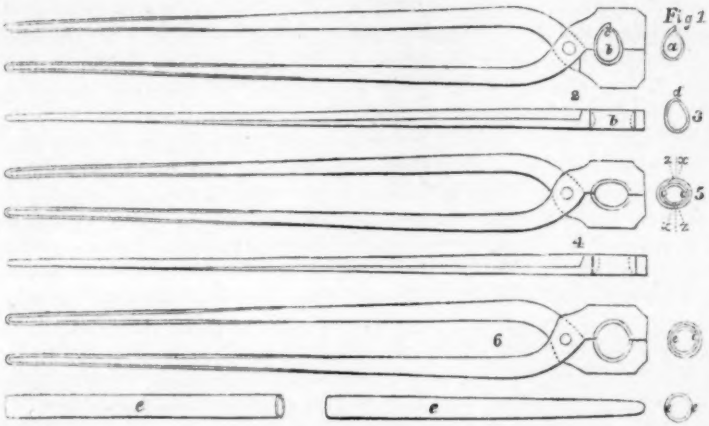
Specification of the Patent granted to THOMAS HENRY RUSSELL, *of the County of Stafford, Iron Tube Manufacturer, and* CORNELIUS WHITEHOUSE, *of the same place, for Improvements in the Manufacture of Welded Iron Tubes.*—Sealed March 7, 1842.

To all to whom these presents shall come, &c. &c.—Our invention relates to improvements in welding the joints, or seams, of wrought iron tubes, when made by external pressure, by passing the iron in a welding state between dies, or through holes; and the improvements consist of a means of employing internal support, and in such manner that the instrument which gives the internal support being introduced into a partly formed tube, is caused to pass with the tube through the dies, or holes, used, by which the requisite external pressure is obtained; and when the weld is completed, the instrument used for giving internal support, owing to its being of small diameter when compared with the diameter of the finished tube, may readily be withdrawn by causing the welded tube to be pressed into a cylindrical form. And in order that our invention may be most fully understood, and readily carried into effect, we will proceed to describe the accompanying drawings.

Description of the Drawings.

a, fig. 1, represents an end view of a skelp of iron turned into the shape shown. This skelp being heated to a light or moderate weld-

ing heat, is drawn through the tongs, *b*, fig. 2; these tongs have a bell, or enlarged mouth opening, and the upper part at *c*, is so sunk as to cause the turned skelp of iron to assume the shape shown at fig. 3—



one edge of the skelp touching the inner surface at the other edge of the skelp, which is caused to overlap, as is clearly shown at *d*, and a partial weld is thus effected. A cylindrical bar, or rod, of iron, *e*, is then introduced into the interior of the skelp, or partly formed tube, and the skelp, or partly formed tube, is to be heated to a welding heat, and then, by means of a draw-bench, the tube, with the instrument, *e*, within it, is drawn through the hole in the dies, or tongs, fig. 4, the pressure being in the direction of the dotted line, *y*, *y*, by which the metal of the joint, or seam, will be pressed together, and the instrument, *e*, which will not have become very highly heated, will be securely held in the tube. The tube being kept at a welding heat, is turned round slightly, and again drawn through the hole of the die, or tongs, fig. 4. In this instance, the principal pressure will, however, be in the direction of the dotted lines, *z*, *z*, in fig. 5, and the seam, or joint, will be pressed on a little on one side of the central line thereof. Then the tube is again drawn through a hole in the tongs, or dies, fig. 4, which are caused to give the principal pressure a little on the other side of the central line of the seam, or joint, as is indicated by the dotted lines, *x*, *x*, fig. 5, the tube being turned in such manner that the tongs may grasp it in the positions indicated by the dotted lines, *x*, *x*, and *z*, *z*, by which means a very effective lap-joint and weld will be obtained to the tube. We prefer to use three pair of tongs, fig. 4, for this purpose, so that the tongs used for each time of drawing may be immediately put into water, and any scale which may adhere removed. The tube is then drawn through the hole in the die, or tongs, fig. 6, which causes the tube to assume a cylindrical shape; and, owing to the smaller diameter of the rod, or bar, *e*, it will be immediately released, and may readily be withdrawn from the welded tube.

We would remark, that we prefer the pressing dies used to be in the form of tongs, owing to the cheapness of their construction and the facility they offer for being cleansed, by dipping them in water after each time of use, when the scale (if any adhere) may be readily removed; such construction of dies also allowing the workman to change from one size of tube to another more readily. At the same time, we do not confine ourselves to the use of dies in the form of tongs, as grooved rollers or other dies—such, for instance, as are described in the specification of Cornelius Whitehouse, of the 26th day of July, 1825—may be used for performing the welding process when the internal support, *e*, has been introduced; but we consider hand dies in the shape of tongs to be the best. The workman in using the tongs rests them against a suitable stop formed on the draw-bench, and he causes the parts of the die to close as the tube begins to pass through the die.

We would also remark, that the dies, and the manner of using them, shown and described, are very similar to those now used in the making of welded iron tubes, according to the specification of the former patent granted to the said Cornelius Whitehouse, they differing only in the shape of the bell mouth given to them respectively.

And we would wish it to be understood, that we do not claim the using of such dies when uncombined with the use of an internal support, *e*, similar to that shown in the drawing, nor do we claim the use of an internal support when using external pressure in welding iron tubes, unless the instrument for giving internal support be such as to pass with the tube through the holes, or dies, used, and offer internal support from end to end of the seam, or joint, of the tube, which is to be welded; the bar, or rod, *e*, being of such diameter, in respect to the tube, that on shaping the tube, the bar, or rod, *e*, shall be released, as before mentioned, so as to be readily withdrawn, owing to the smallness of the diameter when compared with the tube welded thereon. It will, therefore, be seen, that the tube does not move or slide on the bar, or rod, *e*, when the process of welding is being performed. In order to obtain lightness of the instrument, *e*, used for giving internal support, we prefer that it should be hollow, and we have used strong welded iron tubes for this purpose. The instrument, *e*, is longer than the tube welded thereon, and protrudes a short distance through at each end; and care is to be observed in raising the tube to a welding heat, that the ends of the partly-formed tube, and also of the instrument, *e*, are to be kept out of the strong action of the fire, in order to prevent those parts being raised to a welding heat. For this object we have a hole at the back of the furnace for the end of the instrument, *e*, to protrude through, and for the end of the tube to enter, so that the heat is applied to the tube only, and not quite up to the end thereof; and when the fire, or furnace, is not sufficiently long to heat the length of tube desired at one heat, then we first make the tube in the manner described above, for a part of the length of the skelp, and when the same has been cooled, we insert the instrument, *e*, and finish the other end of the skelp by raising it to a welding heat, and drawing it in like manner to the first end of

the skelp. The tube thus made is subsequently raised to a bright red heat, or a moderate welding heat, and is drawn through a pair of dies rather less than those at fig. 6, which slightly reduces the diameter of the tube, and brings it to the size desired. The tube is then to be straightened as heretofore, and the ends cut off, when the tube will be complete. We prefer that the instrument, *e*, should simply be straightened, and not cooled down between each succeeding tube in which it is used, it being desirable to keep the instrument, *e*, hot. We would observe, that this invention is particularly applicable when thin welded iron tubes are desired, such as for the tubular flues of locomotive, or similar steam-boilers, for which purpose we are now using iron of No. 14, of the wire gauge, and we are now making such tubes from one and a half to two inches diameter; but these dimensions may be varied. The drawings show the size of the bar, or rod, used, when making tubes of two inch internal diameter; and it will be evident that the diameter of the bar, or rod, *e*, will be varied according to the size to be made.

Having thus described the nature of our invention, we would wish it to be understood that we do not confine ourselves to the various details shown and described, provided the peculiar mode of applying internal support, combined with the welding of wrought iron tubes by external pressure, be retained, whereby a bar, or rod, *e*, though of much smaller diameter than the tube welded thereon, is caused to give efficient support to the seam, or joint, of a tube, when being welded by external pressure, and whereby the bar, or rod, *e*, is caused to pass under pressure with the tube, and be released after the weld is obtained by the subsequent shaping of the tube, as above described.

THOMAS HENRY RUSSELL,
CORNELIUS WHITEHOUSE.
Lond. Repertory.

Specification of a Patent granted to JOHN CARR, *of North Shields, and* AARON RYLES, *of the same place, for an Improved Mode of Operating in certain Processes for Ornamenting Glass.*—Sealed May 9, 1842.

The "improved mode" here patented is stated to consist in the application to glass "of the process usually called by glass-stainers *printing*, with materials which have not heretofore been used in that way, and under circumstances which give great facility for, and make great improvements in, ornamenting glass."

First, as regards the *staining* of glass, the improved mode of operating is stated to be as follows:—"Instead of mixing the staining materials now in use for that operation, when levigated finely and dried, with oil of turpentine, or other volatile oils, or water, as usual, we mix them with boiled linseed, or other oil, such as is now used to mix with enamel colors, when printed on glass; and instead of floating the staining materials over the glass in a liquid state, as is now practised, we print them on, or transfer them as impressions from,

metal plates, in the manner now adopted in the operation of printing enamel colors, and proceed, after the material transferred has been well dried, to fire it for the color required, in the usual way. When we operate with the same staining materials, so mixed with oil as aforesaid, on what is called pot metal, or on pieces of glass which are what is called 'flashed,' opaque and transparent shades are produced, leaving the surface of the glass quite smooth, and not raised in those parts, as in the common mode of applying body color for the purpose of shading."

Second, as regards the operation of what is called *stopping-out*, the patentees give the following directions:—"We also mix the materials used for that purpose into a composition with boiled oil, as aforesaid, and transfer printed impressions on to the glass with it, as before explained, covering such parts as are not to be acted upon, and can then float over the whole surface, including the parts so stopped out, with liquid staining composition, and fire it as usual, to produce the stain; after which, the glass being cleaned, the pattern so printed on it in stopping-out materials, is exhibited in the original color of the glass, and quite distinct from the stained ground; or a printed impression being transferred to the glass in stopping-out materials, as aforesaid, the remainder of the ground may be obscured, as it is called, in the usual manner—thus producing transparent patterns on obscured grounds."

Third, as regards the operation of what is called *obscuring* glass, the patentees say:—"We also mix the materials which are used to produce this effect with boiled oil, and transfer impressions from engraved metal plates on to the glass; this produces obscured patterns on transparent grounds. Now, whereas, it is evident that in all processes for ornamenting glass, by staining, stopping-out, or obscuring, the means we have discovered of mixing the staining, the stopping-out, and the obscuring materials, with boiled linseed oil, so as to enable us to print with the composition from copper, or other engraved metal plates, gives us the power of greatly improving, perfecting, diversifying, and multiplying, the combinations of patterns, grounds, and devices—while it does not deprive us of the aid of enamel colors to add to that diversity as usual."

The claim is to the use in those processes for ornamenting glass, where staining, stopping-out, or obscuring materials, are employed; of 1st, the mode before described of transferring the said materials in the form of impressions from engraved plates of metal on to the glass, in the same manner as now practised in printing in enamel on glass, namely, by mixing the said materials with boiled linseed or other oil, and 2nd, of the application of the staining material, so mixed with oil, to pot metal or to flashed glass generally. The patentees add, that by "the said improved mode of operating with the said materials, we are enabled greatly to improve, perfect, render more exact, diversify, and multiply the combinations of patterns, grounds, and devices for ornamenting such glass as aforesaid, and to produce the same, so ornamented, at a cheaper rate."

Mech. Mag.

Specification of the Patent granted to GOLDSWORTHY GURNEY, *Esq., Bude, Cornwall, for certain Improvements in the Production and Diffusion of Light.*

My invention relates, first, to a mode of improving the illuminating powers of coal gas, by subjecting it to the chemical action of certain substances hereafter mentioned, in its passage from the gas main to the burners.

Secondly, my invention relates to a mode of applying reflectors, whereby the light produced may be more beneficially diffused, and, in conjunction with the use of such reflectors, the application of certain glass refractors of light.

Thirdly, my invention relates to the application of gas-burners made of concentric rings of tubing, perforated on the upper surfaces, for the passage of gas, when such burners are used in combination with glass chimnies, for lighting apartments and other places; and,

Fourthly, my invention relates to a mode of applying conical glass chimnies to lamps, in order to keep the flames thereof quiet, and most beneficially to supply them with air. And in order that my invention may be most fully understood, and readily carried into effect, I will proceed to describe the means pursued by me in carrying out my invention. It is well known that the use of gas as a means of lighting rooms and internal parts of buildings, is comparatively little resorted to, owing to offensive smell, its great heat, and other objections arising from other causes. Now the first part of my invention has for its object the submitting of gas, in its passage from the supply-main to the burner, or burners, to the chemical action of certain matters hereafter mentioned, whereby gas will not only be greatly improved in its illuminative powers, but, at the same time, the heat of the burning gas will be reduced, and its use in rooms and apartments rendered inoffensive. The materials I employ for this purpose are muriate of zinc, sub-acetate of lead, chloride of baryta, and sulphate of manganese; and these materials are to be used either dry or slightly moistened, in similar vessels to what are used in purifying gas by what is called the dry-lime process, by which the gas in its passage through the vessel is caused to pass in contact with as extensive a surface of the materials used as possible. And the object of the invention is to give to the consumer the opportunity of heating the gas to be consumed by him according to my invention, after it has passed through the ordinary processes of the gas-works; and for this purpose I apply a vessel of the description above mentioned to the gas supply-pipe, by which the gas in passing from the gas-main of the gas company, may pass amongst, and be chemically acted on by, the matters above mentioned, or some of them, before coming to the burner or burners. The most important of the above-mentioned materials is the muriate of zinc, and the use of that material alone will be found of great benefit; but I prefer to use therewith a mixture of the other matters above mentioned, and the mixture I have found best for the purpose is as follows:—5 parts muriate of zinc; 2 parts sub-acetate of

lead; 2 parts chloride of baryta; 4 parts sulphate of manganese. And I have found that about 6 lbs. of the mixture, placed in a vessel of the description above mentioned, (and which is well known,) and of about the following dimensions: 2 feet 6 inches long, 1 foot 6 inches wide, and 1 foot deep, to a supply-pipe of three-quarters of an inch internal diameter, and in proportion for larger or less supply-pipes, fully answers the purpose; and when in constant use, the materials above mentioned should be changed about every three or four weeks.

I would remark, that although I prefer the above described means of applying the above-mentioned materials, I do not confine myself thereto, so long as the means resorted to are such as to bring the gas in contact with muriate of zinc, with or without other suitable matters, in the passage of the gas from the gas-main to the burner, or burners.

GOLDSWORTHY GURNEY.

Mining Jour.

Specification of a Patent granted to ROBERT STIRLING NEWALL, *of the County of Durham, for Improvements in the Manufacture of Flat Bands.*—Enrolled May 16, 1842.

The improvements of the present patentee consist in manufacturing the flat bands used in mining operations, and for driving machinery, *exclusively of iron or other metals.* Three processes are described. According to the *first*, a flat band is manufactured, by subjecting a piece of iron, or other metal, of good quality—preferring that known as the best charcoal iron, manufactured in the usual way by rolling—to a process of drawing through rectangular orifices, or dies of hardened steel, in the same manner as in the ordinary and well known operations of tube or wire drawing. The patentee considers it to be of importance that the piece of metal to be operated upon should be drawn through the die, in a straight line at right angles to its edge; and as it is difficult to roll iron beyond a certain length, he suggests that it may be found convenient to draw it in a hot state through dies. Again, as in the process of drawing, the metal becomes hardened, the patentee directs that (if necessary) it should be annealed, by heating it in a furnace; and after the oxide has been removed from it, by means of diluted sulphuric acid, that the process of drawing should be repeated when cold. When a band of considerable length is required, it may be necessary to unite two or more bands together. Various methods of effecting this junction are pointed out and illustrated by drawings. Scarfing the ends, and riveting, are considered to be much preferable to welding or brazing, as the operation of hammering in welding gives a brittleness to the metal, which no subsequent process of annealing can remove, so as to give the hammered part the same strength which it had before; and in brazing, the union of the two metals is not such as can be trusted to. These bands, when of iron, may vary in thickness from one-twentieth to one-fourth of an inch, and in breadth according to the strength required. Flat bands, manufactured in the way described, are stated to possess greater

strength and durability than those of hemp, or any similar material of the same weight; and if extreme lightness, with the greatest degree of strength, be required, steel may be used instead of iron. In some situations, where the iron becomes rapidly corroded, the bands may be made of copper, instead of iron or steel.

The patentee's *second* improvement consists in manufacturing flat bands of a combination of narrow bands, or strips, of iron, or other metal; which bands, for some purposes, particularly in deep mines, possess advantages over the flat bands before described, on account of the greater security against accident or sudden breaking which such a combination presents. The strips of metal are arranged side by side, and fastened to cross pieces. Metal drawn through dies, as before described, is used, or metal rolled in strips, taking care to select such as are straight and free from flaws, and, if necessary, to cut their edges true and parallel, which may be done by circular shears. The pieces of which the flat band is to be composed, are laid side by side, and kept in a state of equal tension by weights acting over pulleys, while the cross pieces are riveted on, and jointed at the end by a butt, or by an overlap joint. The cross pieces may be from eighteen inches to five feet apart; the breadth and thickness of the component pieces of the band varying according to circumstances.

The *third* improvement consists in forming a flat band by weaving narrow strips, or wires, of metal, in a loom, the strips, or wires, which constitute the warp, being wound on separate bobbins, and kept at a uniform tension during the operation of weaving. It is stated to be, in most cases, advisable to have the wire used as the weft of smaller size than that used as the warp. Mech. Mag.

The Hot-blast Patent.

This patent expired on the 11th of September for England, and on the 1st of October for Scotland, and has proved one out of the few which are eminently successful to the inventor. Besides being of great national benefit, it has realized a sum of not less than £150,000 to the patentees, and has placed John Beaumont Neilson high in the ranks of the benefactors of, not his country alone, but of mankind—iron being the most useful of the metals, and its cheap production of immense importance in arts and manufactures, on which the conveniencies and comforts of life depend. In no small degree has the economising that valuable mineral, coal, been promoted by this discovery; where formerly nine tons were required in Scotland to make one ton of pig-iron, it is now done by two and a half tons, or less, and inferior descriptions of both coal and ore may be used, which before could not be applied; and from this cause a prejudice has arisen against iron made with hot air, which should rather be attributed to those ores and coals which produce weak iron, than to heated air, which, with proper materials, makes as strong, and even stronger, iron than cold air; even the most prejudiced admit this fact in the case of iron made with anthracite coal. The experiments of Messrs.

Hodgkinson and Fairbairn, made under the direction of the British Association, show this fact in iron from the clay ironstones, and also the red ores. It would only be common justice that some national testimonial should be awarded to Mr. Neilson, and it is hoped that some influential party will take the lead in perpetuating the name of a benefactor who may be classed with Arkwright and Watt in the mighty effects of his discovery. Mining Jour.

Practical & Theoretical Mechanics & Chemistry.

FOR THE JOURNAL OF THE FRANKLIN INSTITUTE.

Kalsomine Paint.

In answer to the many applications as to the "material" and "merits" of the Patent Kalsomine Paint, now working so extensively into notice, I avail myself of information derived from practical men in this city, together with the result of my own personal observations, to give some few ideas on the subject.

I find, by test, that the ingredients of which this paint is composed, are, in the first place, removable by water, after their application, but become permanently fixed by a subsequent operation—an advantage to the painter, as thereby he has an entire command over the material he is using; he can apply as much as is required to a wall, or other surface; if necessary, can remove a part, and when the whole is covered to his satisfaction, he renders it insoluble by the application of a "fixing solution," which, combining with the paint applied, fixes it on the wall, or surface, painted. This is an advantage hitherto unattempted in any system of house-painting, places the art of laying and blending colors entirely in the painter's power, and enables him to use pigments which are more solid than those now in use, but which cannot be mixed in oil. From the nature of the kalsomine material, it must offer every resistance to the action of atmospheric agents, a property of the utmost weight. We all know the uncertainty of many of the more delicate tints used for interior house-painting, either in oil or spirit, bearing the action of the light, and the atmosphere, even for a short time, either flying off or turning darker. Not so, however, with the kalsomine colors. These destructive agents do not appear to affect them, judging from specimens of painting executed some time since. In support of what I say, the uniform and fresh appearance of the delicately tinted pearl panels at the Depôt in Broadway, is a case in point; these, to my knowledge, have been painted eighteen months, and as yet no visible change has taken place. An eminent lecturer on chemistry, in this city, agrees with me on this head; on chemical principles he says that kalsomine paint is indestructible.

Kalsomine is made of various tints. From samples of these colors now before me, I find that No. 1 is a pure white pigment, to be used either alone or as a "base," after the manner of white lead, in oil paints; the numbers following, from 2 to 12, are colors for painting the white, all being of exceeding brightness, and withal soft and agreeable to the eye. These are mixed for use according to very simple instructions, given to purchasers by the patentee.

In reference to the material used in the finishing process, by which the paint is rendered fixed, and, consequently, capable of being washed; this is done by the application of what the inventors call a "fixing solution." By analysis, I am unable to my satisfaction to detect *all* the component parts of this solution, but since the material and peculiar method of working kalsomine, is protected by patent,the publication of what I know on the subject would answer no useful end. I can only say that it answers the purpose intended.

The merits of kalsomine painting, compared relatively with the ordinary mode of interior painting, in lead, oil, quips, &c., I should say from my knowledge of both, as far as I can judge, may be reduced to this—from resistance of kalsomic paint to atmospheric agents, the color neither flies off nor becomes darker, which cannot be said in favor of paint in oil or flatting. Kalsomine paint is also more luminous and agreeable to the eye; all the surfaces I have seen painted with it are, certainly, brighter, and at the same time mellower, than anything in "flatting" or otherwise. It has a warmth and glow peculiar to itself, diffusing and softening light, and materially lighting up rooms comparatively dark. Being free from smell, from its nature incapable of injurious effect upon health, and drying in one-sixth of the time of ordinary paint, it is peculiarly advantageous and available to families to whom it would be inconvenient to leave their dwellings while painting. I have myself slept in a room painted during the day, and should not have remarked that it was fresh but for the glow I have already spoken of.

In well kept rooms I believe that kalsomine paint will stand in the ratio of three to one, compared with the old system, in permanence of color. Time will attest what I say, or, with others, I am sadly in error in my judgment.

If I am asked whether kalsomine painting is cheaper than that done by the old method, I answer—the first cost is below that of the old method. Painters in this city, whose work they will warrant to answer the end promised—to be guaranteed by the patentee—offer to paint for me, on plain surfaces, for fifteen per cent. less than they would do the same in oil or flatting. It is, therefore, cheaper, and

even at the same price, it is cheaper, if what I have already asserted is correct, being, from its nature, more permanent.

Many other points might be adduced in favor of kalsomine paint, which are obvious from what I have already said, but, per contra, it has its disadvantages when compared with white lead in oil. From the exceeding brightness and delicacy of its tints, it is soiled more readily, and, therefore, for many parts of interior house-painting, it is exceptionable. The idea of introducing kalsomine paint to supersede entirely the use of white lead in oil for house-painting, is ridiculous, if such was ever the intention of the patentees. Kalsomine paint has been washed in my presence, and in some cases I doubt not that washing carefully improves it; but whether, if introduced into the culinary department and the like places, it would stand the operations of careless servants, without being more impaired than the white lead in oil, I leave for others to prove. I should not recommend it for such work.

The foregoing remarks, the result of actual experiment, enquiry, and observation, are offered, believing that they will be acceptable to many individuals, if they have found the same difficulty with myself in obtaining correct information.

In conclusion, if we can get our houses painted cheaper, to look as well and to last as long, to be applied quicker, and without the disagreeable effluvia attending the use of white lead, oil, and turpentine, then is kalsomine paint preferable, and a benefit to the public. The material may be depended on, and all that is to be feared is its injudicious application. W.

New York, October, 1842.

FOR THE JOURNAL OF THE FRANKLIN INSTITUTE.

To the Committee on Publication:

Gentlemen:—I am uncertain whether you may not deem the following remarks out of place in the Journal, as they may be supposed more nearly related to the subject of natural history than to those to which your publication is more immediately devoted.

Very respectfully,

Thos. Ewbank.

New York, September 20, 1842.

The Ingenuity of Spiders.

The mechanical resources of the lower animals have often excited admiration, and though no comprehensive and systematic series of observations have yet been made upon them, the time is, I believe,

not distant when the task will be undertaken—perhaps within the next century. But whenever and by whomsoever accomplished, the mechanism of animals will then form the subject of one of the most interesting and *useful* volumes in the archives of man.

Among insects, spiders have repeatedly been observed to modify and change their contrivances for ensnaring their prey. Those that live in fields and gardens often fabricate their webs or nets vertically. This sometimes occurs in locations where there is no object sufficiently near to which the lower edge or extremity of the web can properly be braced; and unless this be done, light puffs or breezes of wind are apt to blow it into an entangled mass. Instead of being spread out, like the sail of a ship, to the wind, it would become clewed over the upper line, or edge, like a sail when furled up. Now how would a human engineer act under similar circumstances? But ere the reader begins to reflect, he should bear in mind that it would not do to brace the web by running rigging from it to some *fixed* or immovable object below—by no means;—for were this done, it could not yield to impulses of wind; the rigging would be snapped by the first blast, and the whole structure probably destroyed.

Whatever contrivances human sagacity might suggest, they could hardly excel those which these despised engineers sometimes adopt. Having formed a web, under circumstances similar to those to which we have referred, a spider has been known to descend from it to the ground by means of a thread spun for the purpose, and after selecting a minute pebble, or piece of stone, has coiled the end of the thread round it. Having done this, the ingenious artist ascended, and fixing himself on the lower part of the web, hoisted up the pebble until it swung several inches clear of the ground. The cord to which the weight was suspended was then secured by additional ones, running from it to different parts of the web, which thus acquired the requisite tension, and was allowed, at the same time, to yield to sudden puffs of wind without danger of being rent asunder.

A similar instance came under my notice a few days ago. A large spider had constructed his web, in nearly a vertical position, about six feet from the ground, in a corner of my yard. The upper edge was formed by a strong thread, secured at one end to a vine leaf, and the other to a clothes line. One part of the lower edge was attached to a Persian sun-flower, and another to a trellis fence, four or five feet distant. Between these there was no object nearer than the ground, to which an additional brace line could be carried; but two threads, a foot asunder, descended from this part of the web, and, eight or ten inches below it, were united at a point. From this point, a single line, four or five inches long, was suspended, and to its lower

extremity was the weight, a *living one*, viz. a worm, three inches long, and one-eighth of an inch thick. The cord was fastened around the middle of the victim's body, and as no object was within reach, all its writhings and efforts to escape were fruitless. Its weight answered the same purpose as a piece of inanimate matter, while its sufferings seemed not in the least to disturb the unconcerned murderer, who lay waiting for his prey above.

Whether the owner of the web found it a more easy task to capture this unlucky worm and raise it, than to elevate a stone of the same weight, may be a question. Perhaps in seeking for the latter, the former fell in his way, and was seized, as the first suitable object that came to hand—like the human tyrant, (Domitian) who, to show his skill in archery, planted his arrows in the heads of men or cattle, in the absence of other targets. It may be, however, that a piece of stone, earth or wood, of a suitable weight, was not in the vicinity of the web.

To observe the effect of this weight, I separated, with a pair of scissors, the thread by which it was suspended, and instantly the web shrunk to half its previous dimensions—the lower part became loose, and with the slightest current kept shaking like a sail shivering in the wind. A fresh weight was not supplied by the next morning; but instead of it, two long brace lines extended from the lower part of the web to two vine tendrils, a considerable distance off. These I cut away, to see what device would be next adopted, but on going to examine it the following day, I found the clothes line removed, and with it all relics of the insect's labours had disappeared.

Report on the Bude Light. By Andrew Ure, *M. D., F. R. S.*

From the report of a committee of the House of Commons, it appears that this light is so called from *Bude*, in *Cornwall*, the residence of its inventor, Mr. Gurney—a name bestowed upon it at the Trinity House, to distinguish it from the ignited light which he first described in his work on chemistry, in the year 1823.

The Bude light originally consisted of an oil argand flame, having a stream of oxygen thrown up over its internal surface, which produced a very vivid illumination. It was found, however, after having been used for some time in lighting the House of Commons, that oil lamps thus fed with vital air, were expensive and difficult to regulate.

Mr. Gurney then tried to illuminate the House with naphthalized coal gas, in argand burners, similarly supplied with oxygen; and though this produced a light of sufficient intensity, he encountered a formidable obstacle to its continuance from the deposition of liquid naphtha in the tubes of distribution. He next happily discovered a

method of obtaining, from ordinary coal gas, purified in a simple apparatus of his own, and burned with oxygen derived from the atmosphere, an effulgence adequate to every purpose of internal and external illumination, which is now used in the House of Commons with perfect success, and at a cost of only twelve shillings per night, whereas that of the candles previously used there amounted to six pounds eleven shillings per night.

This new Bude light possesses the following advantages over all other kinds of artificial illumination hitherto displayed.

First—it gives as much light as the best argand gas flames, with only one half the expenditure of gas. This very remarkable fact was established by experiments, carefully conducted, with the same standard wax candles which I employed for comparison prior to my examination before the late committee appointed to ascertain the best mode of lighting the House of Commons. A common argand gas flame was found to emit a light equal to ten such candles (three to a pound,) and a Bude burner, called No. 10, gave a light equal to 94.7 of the candles. Thus, the Bude flame had nearly ten times the illuminating power of the gas argand flame, while by means of an accurate gas metre, the former was ascertained to consume only 4.4 times the quantity of gas consumed by the latter, demonstrating the economy of the Bude light over common gas to be greater than two to one; and this economy increases in proportion to the magnitude of the light. The source of this surprising superiority may be observed by comparing the two flames: the base of the argand gas flame is of a blue tint for fourteen-sixteenths of an inch, a space in which the gas burns with intense heat, but little or no light; whereas the base of the Bude flame acquires a dazzling whiteness at three-sixteenths of an inch from the metal. Thus we see, that, through a range of eleven-sixteenths of an inch, the common argand gas flame is wasted in producing the nuisance of heat without light.

Secondly—from the phenomena just noticed, as also from the circumstance of the Bude flame emitting a double light with a single volume of gas, when compared with the gas argand, it is manifest that the former, in equal degree, can disengage at the utmost only one-half the heat that the latter does.

Thirdly—the Bude light simplifies greatly the means of artificial illumination, since it concentrates in one flame as much light as will diffuse, throughout a large apartment, a mid-day lustre, which may be softened by shades of every hue, and reflected by mirrors in every direction.

Fourthly—from this property proceeds its value as a ventilator, since the single tube which carries off the burned gases serves to draw out, also, the effluvia from a crowded chamber.

From all these facts, I am of opinion that Mr. Gurney's new Bude light is a most meritorious invention in reference to both public and private buildings, as it removes altogether the objections hitherto justly urged against the use of the highly hydrogenous gas of the London companies in dwelling houses—namely, that its heat is great in

proportion to its light, when compared with the more highly carburetted gases of Edinburgh and Glasgow.

The time must, therefore, be now at hand when the great economy and convenience of lighting private houses with gas will be experienced by the inhabitants of the metropolis, as they have been for such a considerable time by those of every town of importance in Scotland.

That the same quantity of coal gas may be made to produce a double amount of illumination in Mr. Gurney's patent burner to that obtained from it in an ordinary argand, will appear to many a paradoxical, if not a doubtful, proposition. Of its reality, however, I am fully convinced, and I think the fact may be accounted for in the following way:

Light, in general, is proportional to the intensity of ignition, a truth well exemplified in the effect of the oxy-hydrogen flame upon a bit of lime or clay. On the same principle, when the flames of two candles are brought into close contact, they afford a compound light considerably greater than the sum of their separate lights. Now, Mr. Gurney's burner gives such a compound flame. It consists of two or more concentric cylinders of flame, mutually enhancing each other's temperature, just as in Fresnel's polycycle oil argand lamps, used in the French lighthouses.

In addition to the augmented intensity of ignition, we must also take into account the peculiar nature of the combustion of carburetted hydrogen gas, whether as generated from coal in a retort, or from oil in a lamp. The vivid whiteness of its flame is due to the separation in solid particles, and subsequent ignition, of its carbon. Pure hydrogen, when burned, affords a very feeble light; and whenever so much air is mixed with coal gas as is sufficient to consume all its carbon simultaneously with its hydrogen, it burns with a dim blue flame.

Now, in the base of a common argand flame, an excess of cold atmospheric oxygen is allowed to act upon the coal gas in the vacant spaces between the pin-holes, whereby the temperature being greatly lowered, while the carbon is consumed in the gaseous state, the light from these two causes is nearly null. It is not till the gaseous mixture rises and forms a continuous hot cylinder, without interstitial streams of air, that it emits a white light from the ignited particles of the carbon precipitated in the interior of the flame.

In Mr. Gurney's concentric series, the prejudicial excess of atmospheric air is prevented, and only so much permitted to come into contact with the gas as will effect the due separation and ignition of its carbon, even at the origin of the flame.

To these two causes conjoined—viz., the increased intensity of ignition, and the limited supply of oxygen—it is that the new Bude flame owes its economy of illumination. The effect of oxygen in excess is elegantly demonstrated by throwing up a stream of it within a gas argand flame, for the light is thus nearly annihilated, while the heat is prodigiously augmented.

As regards the specification of the patent for this improved mode

of lighting, which I have carefully examined, I have no hesitation in declaring it, in my opinion, to be valid and unimpeachable.

Lond. Jour. of Arts, Sci., & Manufac.

Notice of Experiments regarding the Visibility of Lights in Rapid Motion, made with a view to the Improvement of Lighthouses; and of some peculiarities in the impressions made by them on the Eye. By ALAN STEVENSON, *LL. B., F. R. S. E., Civil Engineer.*

In experimenting on this subject, I used the apparatus formerly employed by Captain Hall. It consisted of an octagonal frame, which carried eight of the disks that compose the central part of Fresnel's compound lens, and was susceptible of being revolved slowly or quickly, at pleasure, by means of a crank handle and some intermediate gearing. The experiments were nearly identical with those made by Captain Hall, who contrasted the effect of a single lens at rest, or moving very slowly, with that produced by the eight lenses, revolving with such velocity as to cause an apparently continuous impression on the eye. To this experiment I added that of comparing the beam thrown out by the central portion of a cylindric refractor, such as is used at the fixed light of the Isle of May, with the continuous impression obtained by the rapid revolution of the lenses. Captain Hall made all his comparisons at the short distance of one hundred yards, and in order to obtain some measure of the intensity, he viewed the lights through plates of colored glass until the luminous disks became invisible to the eye. I repeated these experiments at Gullan, under similar circumstances, but with very different results. I shall not, however, enter upon the discussion of these differences at present, although they are susceptible of explanation, and are corroborative of the conclusions at which I have arrived, by comparing the lights at a distance of fourteen miles, but shall proceed to detail the more important results which were obtained by the distant view. Several members of the Royal Society witnessed the results of the experiments, which I shall briefly describe in the following order:

1. The flash of the lens revolving slowly was very much larger than that of the rapidly revolving series; and this decreasing of size in the luminous object presented to the eye, became more marked as the rate of revolution was accelerated, so that at the velocity of eight or ten flashes in a second, the naked eye could hardly detect it, and only a few of the observers saw it; while the steady light from the refractor was distinctly visible.

2. There was also a marked falling off in the brilliancy of the rapid flashes as compared with that of the slow ones; but this effect was by no means so striking as the decrease of volume.

3. Continuity of impression was not attained at the rate of five flashes in a second, but each flash appeared to be distinctly separated by an interval of darkness; and even when the nearest approach to

continuity was made, by the recurrence of eight or ten flashes in a second, the light still presented a twinkling appearance, which was well contrasted with the steady and unchanging effect of the cylindric refractor.

4. The light of the cylindric refractor was, as already stated, steady and unchanging, and of much larger volume than the rapidly revolving flashes. It did not, however, appear so brilliant as the flashes of the quickly revolving lenses, more especially at the lower rate of five flashes in a second.

5. When viewed through a telescope, the difference of volume between the light of the cylindric refractor and that produced by the lenses at their greatest velocity, was very striking. The former presented a large diffuse object of inferior brilliancy, while the latter exhibited a sharp pin point of brilliant light.

Upon a careful consideration of these facts, it appears warrantable to draw the following general conclusions:

1. That our expectations as to the effects of light, when distributed according to the law of its natural horizontal divergence, are supported by observed facts as to the visibility of such lights, contrasted with those whose continuity of effect is produced by collecting the whole light into bright pencils, and causing them to revolve with great velocity.

2. It appears that this deficiency of visibility seems to be chiefly due to a want of volume in the luminous object, and also, although in a less degree, to a loss of intensity; both of which defects appear to increase in proportion as the motion of the luminous object is accelerated.

3. That this deficiency of volume is the most remarkable optical phenomenon connected with the rapid motion of luminous bodies, and that it appears to be directly proportional to the velocity of their passage over the eye.

4. That there is reason to suspect that the visibility of distant lights depends on the volume of the impression, in a greater degree than has, perhaps, been generally imagined.

5. That as the size and intensity of the radiants causing these various impressions to a distant observer, are the same, the volume of the light, and, consequently, *cæteris paribus*, its visibility is, within certain limits, proportionate to the time during which the object is present to the eye.

Such appear to be the general conclusions which these experiments warrant us in drawing; and the practical result, in so far as light-houses are concerned, seems sufficient to discourage us from attempting to improve the visibility of fixed lights in the manner proposed by Captain Hall, even supposing the practical difficulties connected with the great centrifugal force generated by the rapid revolution of the lenses, to be less than they really are.

I shall be excused, I hope, for saying a few words in conclusion regarding the decrease in the volume of the luminous object, caused by the rapid motion of the lights. This effect is interesting, from the apparent connexion with the curious phenomenon of irradiation. When

luminous bodies, such as the lights of distant lamps, are seen by night, they appear much larger than they would do by day; and this effect is said to be produced by irradiation. M. Plateau, in his elaborate essay on this subject, after a careful examination of all the theories of irradiation, states it to be his opinion that the most probable mode of accounting for the various observed phenomena of irradiation, is to suppose that, in the case of a night view, the excitement caused by light is propagated over the retina beyond the limits of the day image of the object, owing to the increased stimulus produced by the contrast of light and darkness; and he also lays it down as a law, confirmed by numerous experiments, that irradiation increases with the duration of the observation. It appears, therefore, not unreasonable to conjecture, that the deficiency of volume observed during the rapid revolution of the lenses, may have been caused by the light being present to the eye so short a time, that the retina was not stimulated in a degree sufficient to produce the amount of irradiation required for causing a large visual object. When, indeed, the statement of M. Plateau, that irradiation is proportional to the duration of the observation, is taken, in connexion with the observed fact that the volume of the light decreased as the motion of the lenses was accelerated, it seems almost impossible to avoid connecting together the two phenomena, as cause and effect. Edinb. New Philos. Jour.

Supplement to a Report upon the Apparatus for Heating and Ventilating the Apartments in the Reform Club House. *By* Andrew Ure, *M. D., F. R. S.*

The cheering and bracing action of condensed air, and the opposite effects of rarefied air, upon human beings, formed the subject of several fine physiological experiments made a few years ago, by M. Junot, and described by him in the ninth volume of the *Archives Générales de Médecine.* "When a person is placed," says he, "in condensed air, he breathes with a new facility; he feels as if the capacity of his lungs was enlarged; his respirations become deeper and less frequent; he experiences, in the course of a short time, an agreeable glow in his chest, as if the pulmonary cells were becoming dilated with an elastic spirit, while the whole frame receives, at each inspiration, fresh vital impulsion. The functions of the brain get excited, the imagination becomes vivid, and the ideas flow with a delightful facility; digestion is rendered more active, as after gentle exercise in the air, because the secretory organs participate immediately in the increased energy of the arterial system, and there is, therefore, no thirst."

In rarefied air the effects on the living functions are just the reverse. The breathing is difficult, feeble, frequent, and terminates in an asthmatic paroxysm; the pulse is quick and most compressible; hæmorrhages often occur, with a tendency to fainting; the secretions are scanty, or totally suppressed; and at length apathy supervenes.

These striking results, obtained on one individual at a time, with a

small experimental apparatus, have been recently re-produced, on a working scale, with many persons at once enclosed in a mining shaft, encased with strong tubing, formed of a series of large sheet iron cylinders, riveted together, and sunk to a great depth through the bed of the river Loire, near Languin. The seams of coal, in this district of France, lie under a stratum of quicksand, from eighteen to twenty metres thick, (twenty to twenty-two yards,) and they had been found to be inaccessible by all the ordinary modes of mining previously practised. The obstacle had been regarded to be so perfectly insurmountable, that every portion of the great coal basin that extends under these alluvial deposits, though well known for centuries, had remained untouched. To endeavor, by the usual workings, to penetrate through these semi-fluid quicksands, which communicate with the waters of the Loire, was, in fact, nothing less than to try to sink a shaft in that river, or to drain the river itself. But this difficulty has been successfully grappled with, through the resources of science, boldly applied by M. Triger, an able civil engineer.

By means of the above frame of iron tubing, furnished with an air-tight ante-chamber at its top, he has contrived to keep his workmen immersed in air, sufficiently condensed by forcing-pumps to repel the water from the bottom of the iron cylinders, and thereby to enable them to excavate the gravel and stones to a great depth. The compartment at top has a man-hole door in its cover, and another in its floor. The men, after being introduced into it, shut the door over their heads, and then turn the stop-cock upon a pipe in connexion with the condensed air in the under-shaft. An equilibrium of pressure is soon established in the ante-chamber, by the influx of the dense air from below, whereby the man-hole door in the floor may be readily opened, to allow the men to descend. Here they work in air, maintained at a pressure of three atmospheres, by the incessant action of leathern valved pumps, driven by a steam engine. While the dense air thus drives the waters of the quicksand communicating with the Loire out of the shaft, it infuses at the same time such energy into the miners, that they can easily excavate double the work without fatigue, which they could do in the open air. Upon many of them, the first sensations are painful, especially upon the ears and eyes; but ere long they get quite reconciled to the bracing element. Old asthmatic men become here effective operatives; deaf persons recover their hearing, while others are sensible to the slightest whisper. The latter phenomenon proceeds from the stronger pulses of the dense air upon the membrane of the drum of the ear.

Much annoyance was at first experienced from the rapid combustion of the candles, but this was obviated by the substitution of flax for cotton thread in the wicks. The temperature of the air is raised a few degrees by the condensation.

Men who descend to considerable depths in diving-bells, experience an augmentation of muscular energy, similar to that above described. They thereby acquire the power of bending over their knees strong bars of iron, which they would find quite inflexible, by their utmost efforts, when drawn up to the surface.

These curious facts clearly illustrate and strongly enforce the propriety of ventilating apartments by means of condensed air, and not by air rarefied with large chimney drafts, as has been hitherto most injudiciously, wastefully, and filthily done, in too many cases.

London, May 21st, 1842. Lond. Jour. of Arts.

Photography.

A very remarkable discovery, with respect to the self-transmitting property of figured surfaces, under certain circumstances, has been recently made by Dr. Moser, of Konigsberg, which would seem to indicate that there is something else than *light* concerned in the production of such effects, and that we must look for some fitter term than *Photo*-graphy to designate the branch of science or art to which they belong. The following is the account of this discovery, brought to this country by Professor Bessel, as communicated by him to the late meeting of the British Association, through the medium of Sir David Brewster, and published in the *Athenæum.*

A black plate of horn, or agate, is placed below a polished surface of silver, at the distance of one-twentieth of an inch, and remains there for ten minutes. The surface of the silver receives an impression of the figure, writing, or crest, which may be cut upon the agate or horn. The figures, &c., do not appear on the silver at the expiration of the ten minutes, but are rendered visible by exposing the silver plate to vapor, either of amber, water, mercury, or any other fluid.

Sir D. Brewster stated that he had heard Professor Bessel say, that the vapors of different fluids were analogous to the different colored rays of the spectrum; that the different fluids had different effects, corresponding to those of the spectrum; and that they could, in consequence of such correspondence, produce a red, blue, or violet color.

The image of the *camera obscura* might be projected on any surface—glass, silver, or the smooth leather cover of a book—without any previous preparation, and the effects would be the same as those produced on a silver plate covered with iodine.

This paper gave rise to an animated conversation, in the course of which M. Bessel said that he had seen some of the pictures taken by this process, which were nearly, but not quite, as good as those obtained by Mr. Talbot's process.

Sir D. Brewster said, this was the germ of one of the most extraordinary discoveries of modern days; by it there seemed to be some thermal effect which became fixed in the black substance; and not only so, but M. Bessel informed him that different lights seemed to affect different vapors variously, so that there seemed to be something like a power of rendering light latent—a circumstance which, if it turned out so, would open up very new and curious conceptions of the physical nature of light. On the emission theory, it would be easy to account for this; on the undulatory theory, he could not conceive how it could be possible.

Professor M'Cullagh said, he believed Newton had somewhere

thrown out a suggestion, that luminous particles, as they entered into bodies, might be caught and retained, within certain bounds, by continual attractions.

Sir D. Brewster said, that the experiments which he had performed with nitrous gas seemed to strengthen some such view as this, for, at certain temperatures, we had here an instance of a gaseous body as impervious to light as a piece of iron.

Sir J. Herschell thought it a pity to encumber this new and extensive field of discovery now laid open to them by any speculations connected with the theory, either of undulations or emissions. He had found that paper could be so prepared as that the impressions of some colors might became permanent upon it, while others were not; and thus it became possible to impress on it colored figures by the action of light. He exhibited a piece of paper so prepared, which at present had no form or picture impressed on it, but which was so prepared that, by holding it in strong light, a red picture would become developed on it.

Mech. Mag.

Dr. Payerne's Sub-Aqueous Experiments.

Dr. Payerne repeated on Wednesday last, at the Polytechnic Institution, (for the third time,) his experiment of living under water without communication with the upper air. He descended in the bell precisely at eleven o'clock, and remained there without any other supply of vital air than that which he was able to manufacture for himself (the *how* is the puzzling question) for three hours. The temperature of the Hall, at the time of Dr. P.'s descent, was 74° Fahr., and a thermometer which he took down with him, and examined every quarter of an hour, exhibited the following changes:

Hour.	Thermometer.	Hour.	Thermometer.
11	67	12¾	65
¼	68	1	65
½	67	¼	65
¾	66	½	65
12	65½	¾	65
¼	65	2	65
½	65		

Dr. Payerne states that the only inconvenience he felt was a slight stunning sensation on first descending in the bell, and on emerging from it, occasioned, no doubt, by the sudden transition from one degree of temperature and pressure to another.

Patents for the invention are now in the course of being applied for, and until they are secured, it is not to be expected that any public disclosure of the means made use of by Dr. Payerne will be made.

To demonstrate, in the meanwhile, the practical value of the invention, by a still severer proof than any to which it has yet been subjected, Dr. Payerne has made an offer to the Lords of the Admiralty, to go down *to any depth, in any place they may select, and to remain constantly submerged for the space of twenty-four hours.*

We think it probable their lordships may hesitate to be consenting parties to an experiment so certain, under any circumstances, to be of a very trying description—for nature must require the repose of sleep under water as well as above—and which, for anything yet known to the public, may be full of danger; but we may, at least, confidently reckon on their affording Dr. Payerne every facility and assistance within reasonable and prudent limits, for testing the working capabilities of his system. Ibid.

On the Calcination of the Chlorate of Potass.

At a late meeting of the Academy of Sciences, Paris, a communication was made relative to some experiments, by M. Milon, in the calcination of the chlorate of potass. Fifteen years ago, M. Serullas, professor of the Military Hospital of the Val-de-Grace, announced the discovery of the hypo-chlorate of potass, during the calcination of the chlorate. This unexpected fact excited, at the time, great interest among chemists, the calcination of the potass having long been an operation for the preparation of oxygen. The experiments of Serullas were, therefore, repeated, and were confirmed by all the chemists who performed them. The new formula of the decomposition of the chlorate, was regarded as explanatory of the march of the phenomenon. It appears, however, from the experiments of M. Milon, that something more was to be learned. He has ascertained that the hypo-chlorate of potass is not immediately transformed into the chlorute of potassium and oxygen, but into chlorite and chlorure. He was able to isolate the chlorite of potass, to produce the chlorites of lead and silver, and to prepare chlorous acid, of which he gives the following account: The chlorous acid, formed of one equivalent of chlorine and three of oxygen, corresponding as to its composition and properties with nitrous acid, is, under most circumstances, the most stable of all the compounds which chlorine forms with oxygen. M. Milon describes various means of obtaining it in the greatest state of purity. The most simple and elegant of these consists in treating arsenious acid with nitric acid, perfectly pure, and with the chlorate of potass, chlorous acid is produced with great facility. It is a more highly-colored gas than chlorine, but differing from it in most of its properties. It does not—which is a surprising fact—attack even finely pulverised arsenic, or the other metals which combine so powerfully with chlorine. Exposed to the action of the solar light, it is decomposed, and produces per chloric acid. In this experiment, the solar light acts both as heat and light. Heat alone, however, is capable of producing this result, but light without heat will not. The chlorous acid is slightly soluble in water, to which it communicates a yellow color, with an intensity which may be compared to that of the chlorate of potass. In solution it gives out a vapor, which is at first invisible, but becomes gradually visible, and at length assumes the appearance of a dense fog. A few drops of liquid, thrown into a jar filled with ten litres of damp air, suffice to render it perfectly opaque.

This phenomenon has particularly attracted the attention of M. Arago, who is of opinion that an opaque atmosphere may be produced at will, and thereby lead to the solution of most important problems on the polarization of light, which have hitherto not been resolved for want of the means of observation. The discovery of the chlorous acid is a fact of high importance. It completes the series of the combination of the chlorine and oxygen, and establishes an analogy the more between these compounds and the corresponding compounds of azote.

Mining Jour.

Improved Modification of a New Electrotype Process.

By M. Newsam.

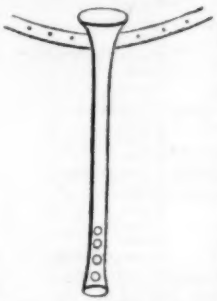
A discovery has been recently made of etching copper plates, by first gilding them by the electrotype, and then delineating the drawing through the coat of gold to the copper. I tried the gilding process several times, but could not succeed in producing a firm coat of metal; and I am acquainted with many scientific gentlemen who arrived at the same result—namely, a dirty black powder, easily rubbed off, instead of the "*glittering metallic surface of incomparable beauty*," as it has been designated by some. Indeed I am half inclined to doubt that such a thing has ever been accomplished. My trials with the "noble" metals proving in every case a decided failure, I thought of trying what could be done by means of the cupreous deposit, as I always found it perfectly pure and firm, provided, only, care were taken in conducting the process. My first experiment proved quite successful; the subject of it was an ordinary steel plate. I covered it with a thin film of copper, which I afterwards etched, and bit up with dilute sulphuric acid. Far finer and closer lines can be formed on this ground than on that in general use at present, which arises from the latter being required to be laid comparatively thicker on, which, together with its property of adhering to the point of the tool, during the process, sometimes sends a whole body of fine line-work into a broken unmeaning mass. What I consider the greatest advantage attending working on a metaliic "ground," is, that after the effect, &c., is bit in, the plate can again undergo the same process, if the resulting etching be not satisfactory—an object not to be attained by the employment of grounds of a waxy or resinous nature. Such grounds always require to be totally removed before the picture can be pronounced perfect—at least as regards the etching; and if the same be found, on inspection, to be not of the requisite degree of color, or depth of tone, the touching up is attended with labor and uncertainty. A plate furnished with a metallic ground, can, however, be bit deeper, even *after* a proof has been printed from it, the coat of metal, of course, being allowed to remain on the plate.

Mech. Mag.

Remedy for Spontaneous Combustion of Coals.

Captain Carpenter, of Her Majesty's steam frigate *Geyser*, has suggested the following remedy for spontaneous combustion.

It is proposed to have several cast iron tubes, with holes at the lower part, as shown in the following figure, passing into the bunker, or coal-hole, nearly to the bottom of the vessel, and only a few inches from the ship's side, properly secured. The upper parts of these tubes are to come up to the deck, and to be contrived so as to give ventilation without allowing wet to go down amongst the coals. At the same time, means are to be afforded of pouring water into the bunkers, so as to flood them at the bottom in case of ignition. The water, in that case, would have a two-fold effect, as it would not only extinguish the fire at the place where danger is to be apprehended, but at the same time, the water poured into the tubes would destroy all ventilation, and have a tendency to smother the part ignited.



The cause of spontaneous combustion is, evidently, first, the accumulation of gases from the moisture of the coals; and then either heat or friction gives rise to ignition. To obviate this evil, if you allow the atmospheric air to pass freely amongst the coals, of course the gases could not accumulate, and combustion would not take place. If, however, there should be parts where the air did not penetrate, then the remedy is effected by pouring water into the bottom of the coal-box, and extinguishing the fire. The smoke issuing from the tube on deck, would always give timely notice of danger; and the hose on deck, pointed into the upper part of the tube, would provide a sufficient supply of water always at hand. The tubes would be about six inches in diameter, and about a quarter of an inch thick; their length would be regulated by the depth of the coal-box.

Hay-stacks are provided with the same remedy against taking fire, by introducing a large basket tube down the centre; and why should not the same result take place in the manner proposed? Ibid.

METEOROLOGICAL OBSERVATIONS FOR JUNE, 1842.

Moon.	Days.	Therm. Sun Rise.	Therm. 2 P.M.	Baromtr. Sun Rise.	Baromtr. 2 P.M.	Wind. Direction.	Wind. Force.	Water Fallen in rain	State of the Weather, and Remarks.	
☽	1	52°	70°	29.90	29.96	W.	Moderate		Clear.	Clear.
	2	50	75	30.00	30.10	E.	do		Clear.	Clear.
	3	48	74	30.05	29.95	E. S.	do		Clear.	Clear.
	4	58	74	29.90	29.85	S.	do		Cloudy.	Cloudy.
	5	64	78	29 80	29.80	SW.	do		Cloudy.	Clear.
	6	64	73	29.75	29.80	W.	do		Cloudy.	Partially cloudy.
	7	48	67	30.10	30.15	E. SE.	do		Clear.	Clear.
⊗	8	48	69	30.25	30.25	SE.	do		Cloudy.	Cloudy.
	9	58	71	30.00	29.90	S.	do	.35	Rain.	Cloudy.
	10	63	75	29.70	29.70	W.	do	.20	Rain.	Clear.
	11	47	60	29.80	29.95	NW.	do		Clear.	Clear.
	12	40	70	30.10	30.10	W.	do		Clear.	Clear.
	13	52	76	30.00	29.95	S.	do		Lightly cl'dy	Lightly cloudy.
	14	62	70	29.90	30.00	E.	do		Clear.	Clear.
☾	15	64	71	29.96	29.96	E. SW.	do	.53	Rain.	Rain.
	16	66	78	29.83	29.83	SW.	do		Cloudy.	Cloudy.
	17	68	73	29.83	29.83	SW.	do	.05	Cloudy.	Rain.
	18	68	79	29.83	29.83	SE.	do	.17	Rain.	Flying clouds.
	19	69	79	29.70	29.70	SW.	do	.35	Cloudy.	Rain; cloudy.
	20	68	72	29.74	29.86	W.	do		Cloudy.	Cloudy.
	21	64	78	29.95	30.00	W.	do		Clear.	Clear.
⊜	22	63	82	29.90	29.83	W.	do		Fog.	Cloudy.
	23	70	73	29.73	29.68	SE.	do	.08	Rain.	Cloudy.
	24	62	72	29.81	29.81	NE.	do		Cloudy.	Cloudy.
	25	62	67	29.84	29.84	W. S.	Brisk		Fog.	Cloudy.
	26	66	80	29.62	29.61	SW.	Moderate	.23	Rain.	Partially cloudy.
	27	68	74	29.58	29.90	E.	do	.14	Par. cloudy.	Rain.
	28	62	76	29.75	29.75	SW.	do		Cloudy.	Flying clouds.
	29	65	82	29.75	29.90	W.	do		Clear.	Clear.
☽	30	66	86	29.94	29.94	W.	do		Clear.	Clear.
		60.13	70.13	29.89	29 89			2.10		

Thermometer. Max. 86.00 on 30th, 27th & 31st. Min. 40.00 on 12th. Mean, 67.13.

Barometer. Max. 30.25 on 8th. Min. 29.58 on 27th. Mean 29.89

SEPTEMBER, 1842.

	1	64°	78°	30.10	30.10	S. SE.	Moderate		Cloudy.	Clear.
	2	64	80	30.00	30.00	W.	do		Clear.	Clear.
	3	69	82	29.95	29.90	SW.	Brisk		Cloudy.	Clear.
⊗	4	68	74	29.96	30.00	NE. SE.	Moderate	.45	Rain.	Cloudy.
	5	72	78	29.84	29.84	W.	do	.14	Rain.	Cloudy.
	6	62	74	29.96	30.00	NE. E.	do		Clear.	Clear.
	7	60	75	29.94	29.94	SW.	do		Cloudy.	Clear.
	8	64	77	29.90	29.90	SE.	do		Par. cloudy.	Partially cloudy.
	9	72	78	29.80	29.90	SW.	Brisk		Cloudy.	Cloudy.
	10	62	69	29.95	30.00	E.	Moderate		Cloudy.	Cloudy.
☾	11	62	75	30.00	29.90	SW.	do		Cloudy.	Lightly cloudy.
	12	72	85	29.73	29.73	W.	Brisk		Cloudy.	Clear.
	13	73	81	29.50	29.50	W.	do		Lightly cl'dy.	Lightly cloudy.
	14	63	65	29.85	29.84	NE.	Moderate	.45	Cloudy.	Rain.
	15	62	69	29.84	29.84	NE. E.	do		Cloudy.	Cloudy.
	16	60	67	29.84	29.86	E.	do		Cloudy.	Cloudy.
	17	54	69	29.90	29.90	W.	Brisk		Lightly cl'dy.	Clear.
	18	54	68	29.80	29.80	W. SW.	do		Lightly cl'dy.	Clear.
⊜	19	56	66	29.80	29.80	NW.	do		Lightly cl'dy.	Lightly cloudy.
	20	48	62	30.00	30.00	W.	do		Clear.	Clear.
	21	48	65	29.85	29.70	W.	do		Lightly cl'dy.	Lightly cloudy.
	22	45	60	29.86	29.86	W.	Brisk		Clear.	Clear.
	23	40	57	30.00	30.00	W.	Moderate		Clear.	Clear.
	24	43	61	30.05	30.05	W.	do		Clear.	Clear.
	25	46	64	30.10	30.10	NW. E.	do		Lightly cl'dy.	Clear.
☽	26	47	67	30.13	30.14	W.	do		Clear.	Clear.
	27	49	70	30.14	30.10	W.	do		Clear.	Clear.
	28	52	74	29.93	29.85	W.	do		Lightly cl'dy.	Clear.
	29	56	72	29.90	29.95	N.	do		Clear.	Clear.
	30	56	65	29.96	29.90	E. W.	do		Cloudy.	Cloudy.
		58.10	70.87	29.92	29.92			1.04		

Thermometer. Maximum 85 on 12th. Minimum 40 on 23rd. Mean64.485

Barometer. Max. 30.14 on 26th. Min. 29.50 on 13th. Mean 29.92

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